Rafferty - Alameda Project

Volume I

Technical Report

Initial Environmental Evaluation

Environment Canada
Conservation and Protection

Environnement Canada
Conservation et Protection

Canada

Rafferty-Alameda Dam Project

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Conservation and Protection
Regina, Saskatchewan

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EXECUTIVE SUMMARY

Background

The Saskatchewan Water Corporation, a Crown agency responsible for water management in the province of Saskatchewan, submitted an application to Environment Canada for a licence for the proposed Rafferty-Alameda Project (henceforth referred to as "the Project") under the International River Improvements Act (IRIA) on January 07, 1988. The purpose of the IRIA is to ensure that the national interest is protected in water resource developments in international rivers. The licence was subsequently issued on June 17, 1988. On April 10, 1989, the Federal Court of Canada quashed the IRIA licence and required Environment Canada to comply with the Environmental Assessment and Review Process (EARP) Guidelines Order in considering the application for a licence.

As the initiating federal department in terms of regulatory functions under the IRIA, Environment Canada identified environmental implications that affect the following areas of federal responsibility:

- transboundary water issues arising from Canada's obligations under Canada/U.S. Treaties and related to the protection of North Dakota and Manitoba interests as a downstream user,
- protection of migratory birds and their habitat,
- protection of fish and fish habitat,
- federal lands,
- protection of rare and endangered species and their habitat, and
- protection of navigable waters.

Project impacts outside these areas of federal responsibility are not dealt with in this Initial Environmental Evaluation (IEE). The project proponent, the Souris Basin Development Authority (SBDA), has previously completed an Environmental Impact Statement which assessed the impact of the Project on areas of provincial concern.

The purpose of this IEE is to document and assess the potential environmental impacts of the Project, as part of the federal EARP. Information is provided on the nature, extent and significance of potential project impacts, proposed mitigation measures, residual impacts and information deficiencies.

To complete this IEE, it was essential that public concerns with the project be identified and incorporated into the recommendations and conclusions of the final IEE. This was achieved through public review of the draft IEE and the public meetings held throughout the Souris River basin. Individuals or groups interested in the Project were also encouraged to present written briefs to Environment Canada.

In considering this IEE, the EARP Guidelines Order requires that the federal Minister of the Environment make a decision within one of four general areas:

(a) environmental effects are understood and can be mitigated, and the project therefore may proceed with prescribed mitigation and monitoring measures,

(b) environmental effects are not completely understood and additional studies are required before a decision can be made on the project,

(c) environmental effects are significant or there is major public concern or both, and a public review by a Panel is therefore required, or

(d) environmental effects are significant and unacceptable, in which case the proposal must either be modified and subsequently re-screened or be abandoned.

Project Description

The Souris River rises in southeastern Saskatchewan and flows south into North Dakota before turning northeasterly to enter Manitoba and join the Assiniboine River near Brandon. Approximately 35 percent of the basin is in Saskatchewan, 39 percent is in North Dakota and 26 percent is in Manitoba. Major tributaries to the Souris in Saskatchewan are Moose Mountain and Long creeks; in North Dakota, Des Lacs, Wintering and Deep rivers; and in Manitoba, Gainsborough Creek and Antler River.

The Project, as defined by the SBDA includes:

- Rafferty Dam and Reservoir on the Souris River, six kilometres northwest of Estevan,
- Rafferty to Boundary Reservoir Diversion Channel,
- downstream channelization from Rafferty to near the Shand Thermal Generating Station, and
- Alameda Dam and Reservoir on Moose Mountain Creek, four kilometres northwest of Oxbow.

The Project is designed to provide flood protection to downstream areas and to provide a more reliable source of water supply to the region. Major flood protection benefits would accrue to the city of Minot, North Dakota, and the United States has conditionally committed $41 million (1985 U.S. dollars) to the project in return for flood protection to the 1:100 level.

Saskatchewan has designed the Project to provide a capability to retain a higher percentage of the natural flow in the Souris River.

A number of associated projects are planned to utilize the more reliable supply of water that would be provided by the Project. These include:

- cooling water for the Shand Thermal Generating Station,

- increased irrigation development, and

- development of recreational and tourism facilities.

The Project would also be operated in conjunction with the existing Boundary Reservoir to increase the storage during flood events and to augment releases to meet flow commitments at the international boundary.

In addition to flood control at Minot, the U.S. Army Corps of Engineers plans to undertake a number of modifications in the United States, known as the Souris River Basin Project, that would be operated in conjunction with the Project. Major features include:

- modification to the Lake Darling dam outlet structure,

- modification to control structures in the Upper Souris National Wildlife Refuge,

- modification to control structures in the J. Clark Salyer National Wildlife Refuge, and

- construction of urban levees at selected sites in North Dakota.

Summary of Adverse Environmental Impacts

If the Project proceeds, altered flows and lake levels within the Souris River basin are expected to cause adverse environmental impacts in a number of areas. These are summarized as follows:

SIGNIFICANT IMPACTS

* **Reduced Downstream Flows**: Flow reductions during years of normally low flow would aggravate an already poor water quality situation in the Souris River in Manitoba. The recreational value of the river would be diminished because of earlier and longer periods of instream biological growth, longer periods of reduced dissolved oxygen, and increased incidence of high free ammonia concentrations. Mitigation options should include flow augmentation alternatives involving modified operational plans and structural considerations in North Dakota, Saskatchewan and Manitoba.

- **Waterfowl Productivity:** Within Saskatchewan and North Dakota the Project would have significant adverse effects on waterfowl production. Complete mitigation of waterfowl impacts is feasible; mitigation plans must be developed for Saskatchewan and North Dakota before the Project proceeds.

- **Lake Darling Fisheries:** The flows entering North Dakota would be reduced by 44 percent and associated water quality effects, would result in a decline and possible elimination of the fish population in Lake Darling. Mitigation options are limited.

- **Fish Habitat:** The Project would result in losses of riverine habitat in Saskatchewan. These losses would be fully mitigated through replacement with reservoir habitat. The Project should achieve "no net loss" of productive habitat in Saskatchewan. In Manitoba the Project would result in the loss or alteration of productive fish habitat. Compensation for this loss or alteration would be required.

- **Federal Lands:** Approximately 1700 ha of federal community pasture lands would be lost to the reservoirs. Full mitigation of the impacts would be achieved through the replacement of pasture lands with lands of equal carrying capacity.

- **Rare and Endangered Species (Plants and Animals):** The Project would have significant adverse effects on the ferruginous hawk (**THREATENED**) and possibly seven plant species of national significance through inundation by the Reservoirs or altered downstream flows through to Manitoba. Opportunities for mitigation would be limited. Over the long term, information on the distribution and abundance of rare plant species in the flood plain is required for Saskatchewan and Manitoba.

- **Navigable Waters:** Both Rafferty and Alameda Reservoirs would impact on navigation. Impacts and concerns for public safety can be mitigated through design and construction considerations, and proper marking of hazards to navigation.

MODERATE IMPACTS

- **International Water Quality:** Reservoir releases would intermittently impact on downstream water quality (free ammonia, dissolved oxygen and dissolved salts). International water quality objectives for both boundaries would be required to determine the acceptability of Project-induced water quality impacts. Mitigation could be accomplished through multi-level outlets and coordinated reservoir releases.

- **Mercury in Fish:** Mercury levels in fish tissue would increase in the reservoirs and possibly downstream. Mitigation options are not well understood. Monitoring and the development of consumption advisories are required in order to protect the public.

- **Baird's Sparrow:** Inundation of the Souris River valley by Rafferty Reservoir would reduce critical habitat and local populations of this **THREATENED** species. Further studies are required to confirm the extent of the loss.

A summary of all Project impacts within Saskatchewan, North Dakota, and Manitoba is provided in the following discussion. Information deficiencies are also identified, together with an assessment of their importance in evaluating impacts.

Environmental Impacts - Saskatchewan

As a result of the Project, Saskatchewan would be able to retain a greater share of the available water in the Souris River and provide improved flood protection to downstream areas. The reservoirs would flood considerable areas of existing farm land, wildlife habitat and floodplain plant communities, while providing higher summer flows below the reservoirs. Operation of the reservoirs would also result in higher than normal flows before and after flood events. Accurate flow forecasts would be required to optimize water management.

Water quality in the reaches of the Souris River below the reservoirs would change as a result of the moderating effect of the new large water bodies. The change would be generally positive for flow-dependent indicators of water quality. There would be intermittent periods when anoxic (low dissolved oxygen) discharges from Rafferty would contain relatively high levels of free ammonia which would be toxic to instream aquatic life. Upsurge of nutrients and salts would occur from the soils inundated by the reservoirs. Increases in salts from upsurge would be masked by the concentrating effects of evaporation. Over the long term, there would be an increasing trend in dissolved salts and nutrients. The nutrients would promote algal growth in the reservoir to the extent that reservoir recreation and aesthetics would be negatively affected. Water quality at the Saskatchewan-North Dakota boundary would vary depending on a number of factors related to flow conditions, reservoir levels and filling rates. During the large flood events, the reservoirs would be replenished with higher quality water which would be released over the following few years.

Mitigation of water quality impacts would require management of reservoir releases to minimize impacts on water quality at the boundary. This could be accomplished by diluting releases from Rafferty with the expected better quality water from Alameda, multiport discharges to reduce the effect of anoxic conditions, and control of activities on and around the reservoirs to protect water quality.

Inundation of waterfowl habitat by the reservoirs and downstream channelization would result in reduced waterfowl production in Saskatchewan in the order of 4400 ducks annually. Such losses would be contrary to the intent and objectives of the **North American Waterfowl Management Plan (NAWMP)** and, without adequate mitigation, would constitute a significant impact. Waterfowl losses could be considerably greater if increased waterfowl harvest near the reservoirs and off-river wetland drainage, stimulated by the Project, were permitted to occur. Mitigation of waterfowl losses would require replacement of lost habitat and waterfowl production, together with restrictions on waterfowl harvest near the reservoirs, and controls on wetland drainage. Extensive monitoring would be required in order to determine whether residual impacts on waterfowl existed after mitigation had been applied.

The Rafferty and Alameda dams would block the seasonal movements of fish between areas downstream and upstream of the proposed dam sites. The Project will achieve 'no net loss' of productive fish habitat in Saskatchewan. Losses in riverine habitat would be replaced by reservoir habitat. Mercury levels in fish are expected to increase in the reservoirs and perhaps downstream. Mitigation options available to reduce the impact of mercury accumulation are not well known. Monitoring and the development of consumption advisories would be required in order to protect the public.

Approximately 1700 ha of federal government community pasture lands administered by the Prairie Farm Rehabilitation Administration (PFRA), Agriculture Canada, would be lost to the reservoirs. Mitigation of the impacts could be achieved through the replacement of pasture lands, with lands of equal productivity, by the SBDA.

Population size of a number of rare plants and the ferruginous hawk could be reduced as a result of inundation by the reservoirs or because of a reduction in flood frequency downstream in the Souris River. Irrigation development associated with the Project could affect a number of rare plants. Piping plover habitat may be enhanced by creation of the reservoirs. No mitigation is possible for impacts on rare plants in inundated areas. No mitigation measures were identified for rare and endangered species impacted by altered downstream flows. Lost habitat for some species could be replaced through means such as nesting boxes, and irrigation development could be designed to minimize impacts on rare plants.

Both the Rafferty and Alameda dams would impact on navigation. Impacts and concerns for public safety could be reduced through design and construction considerations and proper marking of hazards to navigation.

The overall impact of the Project on areas of federal responsibility in Saskatchewan, can be considered significant with respect to transboundary hydrology and water quality, migratory birds, fish habitat, federal lands, and navigation. Some uncertainty exists with respect to the extent of impacts on rare and endangered species. There would be "no net loss" of fish habitat as a result of the Project, however some concern over mercury levels in fish tissue remains.

Although many of these impacts are primarily of provincial concern, there are important implications for areas of federal responsibility, including downstream effects at the boundary and in North Dakota and Manitoba.

Environmental Impacts - North Dakota

The impacts of the Project in North Dakota would result from direct changes in the flow regime and quality of water crossing the international boundary. In addition, change resulting from the Souris River Basin project and proposed changes in the operation of control structures on the Souris River in North Dakota would further impact downstream users. The U.S. Army Corps of Engineers prepared an Environmental Impact Statement (EIS) which addressed the impacts and United States concerns related to the project. The impacts and mitigation measures identified here are based on studies undertaken by U.S. agencies.

The Project would provide major flood control benefits to the U.S. portion of the Souris River, particularly the city of Minot. Due to significant evaporation losses from reservoirs and increased water consumption within Saskatchewan, reduced volumes of water would be available for water users in North Dakota. Operation of the two national wildlife refuges would be affected by an overall reduction in flow volume, combined with prolonged higher flows following the spring peak during flood years. Impacts on water users in North Dakota could be partially mitigated through the operation of national wildlife refuges to optimize water use. Saskatchewan would have to ensure that North Dakota receives its entitled water apportionment.

The quality of water entering North Dakota would depend upon flow conditions, reservoir levels and the quality of water delivered from Saskatchewan. The quality of Souris River water, if principally from Alameda Reservoir, would improve upon existing conditions. The reservoirs would reduce suspended sediment loading to downstream reaches, positively moderate the extremes in dissolved salt concentrations, and slightly increase the potential relative to existing conditions for toxic levels of free ammonia. Impacts (direct and indirect) from the Project would include reduced water volumes and frequency of flushing by high spring flows, increase the TDS in the national wildlife refuges, and an unquantified negative effect on refuge trophic conditions despite anticipated reduced annual nutrient loading. Reduced river flows would have downstream implications to stream assimilative and dilution capacity for handling municipal effluents such as from the city of Minot. Although decreases in monthly flows (about 56 percent of the time) would generally exceed increases (about 24 percent of the time), the increases would generally benefit water quality.

The modified flow regime would adversely affect wetland habitat and management in the Upper Souris and J. Clark Salyer national wildlife refuges. If unmitigated, the loss of waterfowl production from the refuges and Souris River could be in the order of 21 800 ducks annually, and would be significant. The impact of such losses would not be limited to the United States but would also extend to Canada due to the sharing of the international waterfowl resource by the two countries.

The reduced flows into North Dakota would result in a decline and possible elimination of the fish population in Lake Darling. Mitigating options are limited. The change in flow regime could also increase the risk of carp invasion into North Dakota from Manitoba. This may require modification to the J. Clark Salyer National Wildlife Refuge operating plan to minimize impacts.

Within North Dakota, the Project would have significant adverse effects on waterfowl production, particularly in the wildlife refuges, and fish resources. Complete mitigation of waterfowl impacts could be feasible, but opportunities for mitigating adverse effects on fisheries are limited.

Environmental Impacts - Manitoba

As a result of the Project, there would be an overall reduction in Souris River flows and an overall reduction in flood damages in Manitoba. The impact from flooding, however, would be increased in some rural areas where flooding occurs at relatively low water levels. This is a result of prolonged release of flood waters during flood years. Changes in the operation of national wildlife refuges in North Dakota would be required to mitigate these impacts, and improved flood forecasting would be required to reduce the agricultural losses in Manitoba. North Dakota would ensure that Manitoba receives its entitled water apportionment.

The changes in the quality of water delivered to North Dakota from Saskatchewan as a direct result of the Project would not be measurable in Manitoba due to the 660 km river reach in the United States and the complex aquatic environmental processes. The reduced flows and the hydrologic works proposed in the United States in response to the Project, would affect the quality of water in Manitoba. A reduction of water in the United States effectively means that there is less water to absorb the current level of uses, although Manitoba would still receive its entitlement according to the 1959 Measures. The degree to which quality would be changed from existing conditions has not been quantified although best professional judgment would suggest that there would be a gradual long term increase in dissolved substances and a general enhancement of the instream productivity. Any increase to instream productivity is of concern to Manitoba as the river frequently experiences overgrowth to the detriment of asthetics and water-based recreation. Increased incidence of free ammonia would occur principally when flows would be reduced in the summer and fall relative to existing conditions.

Lower than historic annual volumes of water and altered water quality would lead to an overall decline in fisheries values in Manitoba, if compensation is not made for lost and degraded habitat. Some impact on Manitoba fisheries would be anticipated during flood years when flood peaks in Manitoba would be lower but of longer duration. This may adversely affect northern pike and perch spawning. No mitigation options were identified.

The Project is not expected to significantly impact on waterfowl productivity in the Manitoba portion of the Souris River basin. Further study is required in order to confirm this expectation.

Rare plants downstream in Manitoba would be affected to an unknown extent by altered flows in the Souris River.

As a result of the Project, moderate impacts would occur in Manitoba through increases in agricultural flooding in some reaches, increased stream productivity, additional exceedances of the Manitoba objective for free ammonia, as well as reduced fish spawning success and adverse effects on rare plant species. Most of these impacts can be mitigated, while the extent of the impact on fisheries is not fully known. Some uncertainty exists with respect to impacts on rare plant species.

Information Deficiencies

The preparation of this IEE relied primarily on the extensive documentation previously prepared by the Project Proponent (SBDA), other Saskatchewan provincial agencies, federal and state agencies in the United States, Manitoba agencies, Environment Canada and other federal government departments. Some additional data and information were compiled in the areas of hydrology, water quality, rare and endangered species, and migratory birds. The lack of data and information for some areas of concern have placed limitations on the extent to which Project impacts can be assessed. The major areas of deficiency are categorized below as being of significant or moderate importance.

SIGNIFICANT DEFICIENCIES

- The basic data for Saskatchewan from 1974 to 1981 should be reviewed. The hydrology data in Saskatchewan, North Dakota and Manitoba should be updated to 1988, including data on existing and proposed water uses. These data are not required to assess the overall impact of the Project, but are critical for development of a water management plan.

- Operating criteria used in the hydrologic model have been evolving continually since the preparation of the SBDA's EIS. A water management plan should be developed which would include Saskatchewan's operations of the Project, the operation of the national wildlife refuges in North Dakota, and account for Manitoba's entitlement.

- International water quality objectives against which impacts on transboundary water quality can be assessed do not exist. If the Project proceeds, formulation of international water quality objectives should be undertaken immediately for those parameters which are considered most likely to be affected.

- The EISs from the SBDA and the U.S. Army Corps of Engineers do not consider the collective impacts of the Project and the Souris River Basin

Project on the quality of the Souris River at the North Dakota-Manitoba boundary.

- The operation of the national wildlife refuges in North Dakota affect the water quality at the North Dakota-Manitoba boundary. A precise operating plan is required to assess the water quality implications and opportunities for mitigation.

- Comprehensive mitigation and monitoring plans for waterfowl production would be required before a decision could be made on whether the Project should proceed.

- Insufficient information exists on fish habitat in the Souris River in Manitoba. As well, the significance of Lake Darling and its fish populations to the downstream reaches of the Souris River in Manitoba is unknown. Such information is required in order to accurately predict impacts of the Project on fish and to determine suitable compensation options in order to achieve "no net loss" of productive fish habitat.

- Information and data are lacking for comparative evaluations of habitat quality in the flooded area in terms of nesting and foraging value and the surrounding range for the ferruginous hawk.

- The distribution and abundance of rare plant species in the Souris River flood plain in Saskatchewan and Manitoba needs to be studied in more detail. Particular emphasis should be placed on the reach to be inundated by the Rafferty Reservoir.

MODERATE DEFICIENCIES

- Spring flood-flow rejuvenation of the Souris River downstream of the Project would be reduced, relative to existing conditions. It is not known how the effects of this would be manifested in the aquatic ecosystem.

- The water quality models used by the proponent have not been fully field tested, calibrated or verified within the Souris River basin, although some testing was undertaken in 1989. This deficiency places some doubt upon the results.

- Data should be collected on the distribution of riparian and upland waterfowl habitat types, and on the size and composition of the resident breeding waterfowl population, along the Souris River in Manitoba. These data are required in order to substantiate the expectation that the Project would not adversely affect waterfowl production along the Souris in Manitoba.

- Quantitative baseline information is lacking on the status of Baird's sparrow in the Souris valley, particularly in the vicinity of the Rafferty and Alameda Dam sites.

SOMMAIRE ADMINISTRATIF

Données de base

Le 7 janvier 1988, la Saskatchewan Water Corporation, une corporation de la Couronne chargée de la gestion des eaux dans la province de la Saskatchewan, a demandé à Environnement Canada un permis l'autorisant à entreprendre le projet Rafferty-Alameda (ci-après appelé "le Projet") aux termes de la Loi sur les ouvrages destinés à l'amélioration des cours d'eaux internationaux (IRIA). La raison d'être de l'IRIA est d'assurer la protection de l'intérêt national en matière de développements touchant aux ressources en eau dans les cours d'eau internationaux. Le permis a été accordé le 17 juin 1988. Le 10 avril 1989, la Cour fédérale du Canada a annulé le permis et a exigé qu'Environnement Canada se conforme au décret sur les directives du processus d'évaluation et d'examen en matière d'environnement (PEEE) dans ses considérations préalables à l'octroi de permis.

En tant que Ministère fédéral chargé du contrôle aux termes de l'IRIA, Environnement Canada a mis en lumière certaines conséquences environnementales dans les secteurs de responsabilité fédérale suivants :

- questions relatives aux eaux passant la frontière Canada - États-Unis issues des obligations du Canada aux termes des traités entre le Canada et les États-Unis et ayant trait à la protection des intérêts du Dakota du Nord et du Manitoba en tant qu'usagers en aval,
- protection des oiseaux migrateurs et de leur habitat,
- protection des poissons et de leur habitat,
- terres fédérales,
- protection d'espèces rares et en voie d'extinction et de leur habitat, et
- protection des voies navigables.

Les répercussions du Projet en dehors de ces domaines de responsabilité fédérale ne sont pas traitées dans cette évaluation environnementale initiale (EEI). Le promoteur du Projet, la Souris Basin Development Authority (SBDA), a déjà élaboré un énoncé des répercussions environnementales dans lequel il évaluait les répercussions du Projet sur les domaines d'intérêt provincial.

Le but de l'EEI est de documenter et d'évaluer, dans le cadre du PEEE, les répercussions environnementales potentielles du Projet. Elle rassemble des informations sur la nature, l'ampleur et l'importance des répercussions possibles du Projet, des mesures d'atténuation proposées, des répercussions résiduelles et des manques d'information.

Pour pouvoir terminer l'EEI, il était essentiel que les préoccupations du public vis-à-vis du Projet soient connues et incluses dans les recommandations et les conclusions de l'EEI finale. Cela a été accompli grâce à un examen public de l'ébauche de l'EEI et aux audiences publiques tenues dans tout le bassin de la rivière Souris. Les personnes et les groupes intéressés par le Projet ont aussi été invités à présenter des exposés écrits à Environnement Canada.

En ce qui a trait à cette EEI, le décret sur les directives du PEEE exige que le ministre fédéral de l'Environnement décide laquelle des quatre options suivantes retenir :

a) les effets sur l'environnement sont connus et peuvent être atténués; le Projet peut donc aller de l'avant pourvu qu'on applique les mesures d'atténuation et de contrôle requises;

b) les effets sur l'environnement ne sont pas parfaitement connus; des études supplémentaires sont nécessaires avant qu'une décision puisse être prise au sujet du Projet;

c) les effets sur l'environnement ou les inquiétudes du public, ou les deux, sont si importants qu'un examen public par une commission s'avère nécessaire;

d) les effets sur l'environnement sont si importants qu'ils sont inacceptables; la proposition doit être soit modifiée et par la suite réévaluée, soit abandonnée.

Description du Projet

La rivière Souris a sa source dans le sud-est de la Saskatchewan et coule vers le sud et le Dakota du Nord; elle y dessine un coude vers le nord-est et le Manitoba où elle se jette dans la rivière Assiniboine près de Brandon. Environ 35 p. 100 du bassin se trouve en Saskatchewan, 39 p. 100 au Dakota du Nord et 26 p. 100 au Manitoba. Les affluents principaux de la Souris sont : les ruisseaux Moose Mountain et Long en Saskatchewan; les rivières des Lacs, Wintering et Deep au Dakota du Nord; et, au Manitoba, le ruisseau Gainsborough et la rivière Antler.

Le Projet, tel qu'il est défini par le SBDA, comprend :

- le barrage et le réservoir Rafferty sur la rivière Souris à 6 km au nord-ouest d'Estevan,
- le canal de dérivation du réservoir Rafferty au réservoir Boundary,
- le chenal en aval de Rafferty jusqu'à proximité de la centrale thermique de Shand,
- le barrage et le réservoir Alameda sur le ruisseau Moose Mountain à 4 km au nord-ouest d'Oxbow.

Le Projet a été conçu de façon à protéger les régions en aval contre les inondations et à fournir une source plus fiable d'approvisionnement en eau à la région. La ville de Minot au Dakota du Nord en dériverait des bénéfices importants en matière de protection contre les inondations, et le gouvernement des États-Unis a alloué, sous réserve, 41 millions de dollars (dollars US de 1985) pour le Projet en échange d'une protection contre les inondations au niveau de 1:100. La Saskatchewan a conçu le Projet afin d'être en mesure de retenir une plus grande proportion du débit naturel de la rivière Souris.

Plusieurs utilisations associées sont prévues qui s'appuieraient sur un approvisionnement en eau plus fiable découlant du Projet. Elles comprennent :

- de l'eau de refroidissement pour la centrale thermique de Shand,
- l'accroissement de projets d'irrigation, et
- l'aménagement d'installations récréatives et touristiques.

Le Projet serait aussi exploité conjointement avec le réservoir Boundary, déjà en place, pour augmenter la retenue d'eau durant les périodes de crue et d'accroître les décharges pour satisfaire aux exigences de débit à la frontière internationale.

Outre le contrôle des inondations à Minot, le U.S. Army Corps of Engineers entend entreprendre une série de modifications aux États-Unis connues collectivement sous l'appellation Souris River Basin Project qui seraient réalisées conjointement avec le Projet et dont les principales caractéristiques seraient les suivantes :

- modification du système d'évacuation du lac Darling,
- modification des ouvrages de régulation au refuge faunique national Upper Souris,
- modification des ouvrages de régulation au refuge faunique national J. Clark Salyer, et
- construction de digues urbaines à certains endroits au Dakota du Nord.

Résumé des répercussions négatives sur l'environnement

Si le projet Rafferty-Alameda se poursuit, la modification des écoulements et des niveaux des lacs à l'intérieur du bassin de la rivière Souris entraînera vraisemblablement des retombées négatives sur l'environnement dans un certain nombre de cas particuliers.

RÉPERCUSSIONS MAJEURES

* **Réduction de l'écoulement en aval** : La réduction de l'écoulement au cours des années où le débit est ordinairement peu élevé réduirait encore davantage la qualité des eaux de la rivière Souris au Manitoba. La valeur récréative de celle-ci baisserait à cause des périodes plus hâtives et plus longues de croissance biologique dans les cours d'eau, de périodes plus longues où le niveau d'oxygène dissous est moins élevé et une augmentation de la fréquence de hautes concentrations d'ammoniaque libre. Les possibilités d'atténuation devraient comprendre d'autres moyens d'accroître l'écoulement, mettant en cause des plans d'exploitation modifiés et des considérations d'ordre structurel au Dakota du Nord, en Saskatchewan et au Manitoba.

* **Reproduction de la sauvagine** : En Saskatchewan et au Dakota du Nord, le projet Rafferty-Alameda aurait de graves répercussions sur la reproduction de la sauvagine. Toutefois, une réduction totale de ces répercussions est possible, et il est indispensable de préparer un plan d'atténuation pour la Saskatchewan et le Dakota du Nord avant que le projet Rafferty-Alameda n'aille de l'avant.

* **Pêche dans le lac Darling** : En raison d'une réduction de 44 p. 100 de l'écoulement vers le Dakota du Nord et des répercussions sur la qualité des eaux, il s'ensuivrait une diminution ou même une disparition des poissons dans le lac Darling. Les possibilités d'atténuation des répercussions négatives sont limitées.

* **Habitat du poisson** : Le projet Rafferty-Alameda entraînerait des réductions de l'habitat fluvial en Saskatchewan. Toutefois, ces pertes seraient totalement compensées par la création d'un nouvel habitat, celui offert par les réservoirs. Le projet Rafferty-Alameda ne devrait entraîner aucune perte nette d'habitat de reproduction en Saskatchewan. Au Manitoba, il entraînerait une perte ou une profonde modification de l'habitat de reproduction du poisson. Des mesures de compensation pour ces pertes ou modifications s'imposeraient.

* **Terres fédérales** : Approximativement 1 700 ha de pâturages communautaires situés sur des terres fédérales seraient submergés par les réservoirs. L'atténuation complète des répercussions consisterait à remplacer les pâturages submergés par des terres équivalentes.

* **Espèces rares et menacées d'extinction (flore et faune)** : En raison des inondations dues aux réservoirs situés en Saskatchewan et des modifications de l'écoulement en aval jusqu'au Manitoba, le Projet aurait de graves répercussions sur la buse rouilleuse (**ESPÈCE MENACÉE**) et sur peut-être sept espèces de plantes qui présentent un intérêt national. Les possibilités d'atténuation de ces effets seraient limitées. À long terme, il sera indispensable de rassembler pour la Saskatchewan et le Manitoba des données sur l'emplacement et la quantité d'espèces rares de flore dans la plaine alluviale.

* **Eaux navigables** : Les réservoirs Rafferty et Alameda auraient tous deux des répercussions sur la navigation. Des mesures telles qu'une signalisation adéquate des dangers pour la navigation et l'établissement de critères d'étude et de construction appropriés pourraient atténuer les répercussions sur la sécurité publique.

RÉPERCUSSIONS MOYENNES

* **Qualité des eaux internationales** : Les décharges de réservoirs auraient périodiquement des répercussions sur la qualité des eaux en aval (émanations d'ammoniaque, dissolution de l'oxygène et dissolution des sels minéraux). En ce qui concerne la qualité de l'eau, les deux pays concernés devraient définir les critères relatifs aux répercussions sur la qualité des eaux en provenance du projet Rafferty-Alameda. Les répercussions peuvent être atténuées par l'installation de déversoirs placés à des niveaux différents et par une synchronisation des décharges de réservoirs.

- **Présence de mercure dans les poissons** : Dans les réservoirs et peut-être en aval, le niveau de mercure dans la chair des poissons augmenterait. Les mesures d'atténuation sont mal comprises. Une surveillance constante ainsi que des mesures de mise en garde du public relativement à la consommation des poissons devront être mises en place.

- **Bruant de Baird** : L'inondation de la vallée de la Souris par le réservoir Rafferty réduirait l'habitat principal et la population de cette espèce **MENACÉE**. Il sera nécessaire d'effectuer des études supplémentaires afin de déterminer l'ampleur des pertes.

Un résumé de toutes les répercussions du projet Rafferty-Alameda sur la Saskatchewan, le Dakota du Nord et le Manitoba figure ci-dessous. On indique également le manque d'information relativement à certaines questions, et l'on examine son importance dans l'évaluation des répercussions du Projet.

Répercussions environnementales en Saskatchewan

La réalisation de ce Projet permettrait à la Saskatchewan de conserver une proportion plus importante de l'eau de la rivière Souris et d'offrir aux zones en aval du Projet une protection supplémentaire contre les inondations. Les réservoirs submergeraient une superficie importante de terres agricoles, d'habitat de la faune et de la flore alluviale, tout en permettant un écoulement supérieur en aval des réservoirs au cours de l'été. L'exploitation des réservoirs donnerait également lieu à des écoulements supérieurs à la moyenne, avant et après les crues. Des prévisions aussi précises que possible en matière d'écoulement seraient indispensables à une gestion optimale des eaux.

La qualité des eaux dans le bassin de la rivière Souris en aval des réservoirs changerait à cause de l'effet modérateur de nouveaux grands plans d'eau. Ce changement serait en général positif pour les éléments indicateurs de qualité d'eau qui reposent sur l'écoulement. Il y aurait par intermittence des périodes où des décharges anoxiques (diminution de la saturation en oxygène) de Rafferty contiendraient des niveaux relativement élevés d'ammoniaque libre nuisible à la vie aquatique en aval. Il y aurait une forte augmentation de substances nutritives et de sels minéraux provenant des sols inondés par les réservoirs. Cet accroissement des sels minéraux serait masqué par les effets de concentration de l'évaporation. À long terme, il y aurait une production à la hausse de sels minéraux dissous et de substances nutritives. Ces dernières encourageraient la croissance des algues jusqu'à un point où les possibilités récréatives et l'aspect esthétique du réservoir en souffriraient. La qualité de l'eau à la frontière entre la Saskatchewan et le Dakota du Nord connaîtrait des variations en fonction d'un certain nombre de facteurs liés aux conditions d'écoulement, aux niveaux des réservoirs et à la vitesse d'alimentation. En périodes de crues, les réservoirs seraient réalimentés avec une eau de qualité supérieure qui serait évacuée au cours des années suivantes.

L'atténuation des répercussions sur la qualité des eaux nécessiterait la gestion des décharges des réservoirs pour minimiser les effets sur la qualité de l'eau à la frontière. Cela pourrait s'effectuer en diluant les décharges du réservoir Rafferty avec de l'eau de meilleure qualité en provenance du réservoir Alameda, en effectuant des décharges à l'aide de vannes multiples pour diminuer les effets de l'anoxie et en contrôlant les activités sur les réservoirs et dans leurs environs, afin de protéger la qualité des eaux.

La submersion de l'habitat de la sauvagine le long des réservoirs et l'approfondissement du chenal en aval entraîneraient une réduction du taux de reproduction de la sauvagine en Saskatchewan de l'ordre de 4 400 canards par an. Une telle déperdition va à l'encontre de la politique du Plan nord-américain de gestion de la sauvagine (PNAGS) et, en l'absence de mesures adéquates d'atténuation, représenterait une répercussion importante. Les pertes en sauvagine seraient même supérieures si la chasse à la sauvagine à proximité des réservoirs et des zones de drainage des terres humides était autorisée. Les mesures d'atténuation des pertes en sauvagine nécessiteraient le remplacement de l'habitat submergé ainsi que des mesures de restriction de la chasse à la sauvagine à proximité des réservoirs et des zones de drainage des terres humides. D'importantes mesures de surveillance seraient indispensables afin de déterminer l'existence de répercussions résiduelles sur la sauvagine après la mise en place de mesures d'atténuation.

Les barrages Rafferty et Alameda bloqueraient les déplacements saisonniers des poissons en aval et en amont de l'emplacement proposé des barrages. Le Projet n'entraînera aucune perte nette de l'habitat de reproduction du poisson en Saskatchewan. Les pertes en habitat alluvial seraient compensées par la création de nouveaux habitats dans les réservoirs. Par contre, on s'attend à ce que le niveau de mercure dans les poissons augmente dans les réservoirs et peut-être en aval. Les mesures d'atténuation visant à réduire les répercussions de la contamination par le mercure n'ont pas encore été précisées. Il serait nécessaire de mettre en place des mesures de contrôle et de mise en garde du public en matière de consommation du poisson.

Approximativement 1 700 ha de pâturages communautaires situés sur des terres fédérales et administrés par l'Administration du rétablissement agricole des Prairies (ARAP) d'Agriculture Canada, seraient submergés par les eaux des réservoirs. On pourrait remédier à cet état de chose en remplaçant les terres perdues par des pâturages de valeur égale, ce qui serait fait par la SBDA.

La submersion par les eaux des réservoirs ainsi que la diminution de la fréquence des inondations causées par la rivière Souris en aval pourraient entraîner la réduction de certaines espèces rares de flore et de la population de la buse rouilleuse. Les projets d'irrigation connexes pourraient influer sur un certain nombre de plantes rares. Par contre, l'habitat du pluvier siffleur pourrait être amélioré par la création des réservoirs. Aucune mesure d'atténuation n'est possible pour pallier les répercussions sur les plantes rares dans les terres submergées. Les pertes en habitat de certaines espèces pourraient être compensées par la mise en place de nids artificiels et par l'élaboration de projets d'irrigation destinés à atténuer les répercussions sur les plantes rares.

Les barrages Rafferty et Alameda auraient des répercussions sur la navigation. Les dangers pour la sécurité publique pourraient être limités par la modification des plans de conception et de construction et par une signalisation adéquate des dangers liés à la navigation.

Les répercussions du projet Rafferty-Alameda sur les domaines relevant du gouvernement fédéral en Saskatchewan peuvent être perçues comme étant importantes en ce qui a trait à l'hydrologie internationale, à la qualité des eaux limitrophes, aux oiseaux migrateurs, à l'habitat du poisson, aux terres fédérales et à la navigation. Il existe encore certaines incertitudes en ce qui concerne la gravité des répercussions sur les espèces rares et en voie d'extinction. Le projet Rafferty-Alameda ne devrait entraîner aucune perte nette d'habitat de reproduction du poisson. Toutefois, le niveau de mercure dans la chair des poissons demeure une préoccupation majeure.

Bien que la plupart de ces répercussions relèvent des responsabilités provinciales, elles entraînent d'importantes implications pour le gouvernement fédéral, y compris les répercussions en aval des réservoirs, à la frontière, au Dakota du Nord et au Manitoba.

Impacts sur l'environnement - Dakota du Nord

Les répercussions du Projet sur le Dakota du Nord seraient causées par des changements directs au régime d'écoulement et dans la qualité des eaux traversant la frontière internationale. De plus, d'autres répercussions affecteraient les usagers en aval à cause des changements résultant du Projet dans le bassin de la rivière Souris et des changements proposés dans le fonctionnement des ouvrages de régulation sur la rivière Souris, au Dakota du Nord. Le U.S. Army Corps of Engineers a préparé un rapport sur les incidences environnementales (ERE - Énoncé sur les répercussions environnementales) portant sur les répercussions et les inquiétudes américaines relatives au Projet. Les répercussions et les mesures d'atténuation présentées ici sont fondées sur des études menées par des organismes américains.

Le Projet profiterait grandement à la partie américaine de la rivière Souris, surtout à la ville de Minot, puisqu'il permettrait de contrôler les crues. À cause de pertes importantes dues à l'évaporation dans les réservoirs et d'une plus grande consommation d'eau en Saskatchewan, les consommateurs d'eau du Dakota du Nord auraient accès à des volumes d'eau réduits. L'exploitation des deux refuges fauniques nationaux subirait une réduction globale du débit, ainsi que des débits plus importants prolongés suite à la crue du printemps, les années d'inondation. Les effets sur les consommateurs du Dakota du Nord pourraient être en partie atténués par une gestion des refuges fauniques nationaux qui optimaliserait l'utilisation de l'eau. La Saskatchewan devrait s'assurer que le Dakota du Nord reçoive la quantité d'eau à laquelle il a droit.

La qualité des eaux qui entrent au Dakota du Nord dépend du régime d'écoulement, des niveaux de réservoir et de la qualité des apports d'eau en provenance de la Saskatchewan. La qualité des eaux de la rivière Souris, dans la mesure où ces eaux proviendraient principalement du réservoir Alameda, améliorerait les conditions existantes. Les réservoirs réduiraient les charges de matières en suspension dans les biefs en aval, réduiraient nettement les extrêmes dans les concentrations de sel dissous et augmenteraient légèrement le potentiel relatif aux conditions existantes en ce qui concerne les niveaux toxiques de l'ammoniaque libre. Au nombre des répercussions (directes et indirectes) du Projet, on peut mentionner les volumes d'eau réduits et la fréquence de chasse produits par les abondants écoulements printaniers, l'augmentation des matières totales dissoutes dans les refuges fauniques nationaux ainsi qu'un effet négatif non quantifié sur les conditions trophiques des refuges, malgré une réduction anticipée de la charge annuelle en sels nutritifs. Un écoulement fluvial réduit aurait des implications en aval sur la capacité d'assimilation et de dilution nécessaire à l'élimination des effluents municipaux comme ceux de la ville de Minot. Bien que les baisses d'écoulements mensuels (environ 56 % du temps) dépasseraient généralement les augmentations (environ 24 % du temps), les augmentations contribueraient généralement à la qualité des eaux.

Le régime d'écoulement modifié influerait négativement sur l'habitat et la gestion des marais dans les refuges fauniques nationaux Upper Souris et J. Clark Salyer. Sans la mise en place de mesures d'atténuation, la perte de reproduction de la sauvagine dans les refuges et la rivière Souris serait importante, soit environ 21 800 canards par an. L'impact de telles pertes ne serait pas limité aux États-Unis; il se ferait sentir également au Canada à cause du partage des ressources internationales en sauvagine entre les deux pays.

Les débits réduits entrant au Dakota du Nord se traduiraient par une réduction et une élimination possible de la population de poissons dans le lac Darling. Les mesures d'atténuation sont limitées. La modification du régime d'écoulement pourrait aussi augmenter le risque d'une invasion de carpes du Manitoba dans le Dakota du Nord. Afin d'en minimiser l'impact, une modification du plan d'exploitation du refuge faunique national J. Clark Salyer pourrait être nécessaire.

Au Dakota du Nord, le Projet aurait des effets négatifs importants sur la reproduction de la sauvagine, surtout dans les refuges fauniques, et sur les ressources en poissons. L'atténuation totale des impacts sur la sauvagine est réalisable; cependant, les possibilités d'atténuation des effets négatifs sur les pêcheries sont limitées.

Répercussions environnementales - Manitoba

Les conséquences du Projet comprennent une réduction globale des débits de la rivière Souris et une réduction globale des dégâts dus aux inondations au Manitoba. L'effet des inondations serait toutefois aggravé dans certaines régions rurales qui se voient inondées lorsque les niveaux d'eau sont relativement bas. Cela est dû à l'apport prolongé des eaux de crue au cours des années où les crues sont importantes. Il faudrait apporter des changements à l'exploitation des refuges fauniques nationaux du Dakota du Nord pour atténuer ces impacts; un service amélioré de prévision des inondations serait nécessaire pour réduire les pertes agricoles au Manitoba. Le Dakota du Nord devrait s'assurer que le Manitoba reçoive la quantité d'eau à laquelle il a droit.

Les changements subis par la qualité des eaux livrées par la Saskatchewan au Dakota du Nord et attribuables directement au Projet ne seraient pas mesurables au Manitoba du fait que la rivière coule aux États-Unis sur 660 km et à cause de la complexité des processus aquatiques environnementaux. La réduction de l'écoulement et les ouvrages hydrologiques, qu'on propose de bâtir aux États-Unis à cause du Projet, affecteraient la qualité de l'eau au Manitoba. Toute réduction d'écoulement aux États-Unis signifie effectivement qu'il y aura moins d'eau pour répondre aux niveaux actuels d'utilisation, bien que le Manitoba continuerait de recevoir sa part selon la répartition de 1959. On n'a pas établi la mesure dans laquelle la qualité de l'eau changerait bien que les experts suggèrent qu'il y aurait à long terme une augmentation lente de la quantité de substances dissoutes et un accroissement général de la productivité dans le cours d'eau. Tout accroissement de la productivité dans la rivière est inquiétant pour le Manitoba vu qu'elle subit fréquemment des "surcroissances" qui nuisent à son aspect esthétique et aux activités de loisir aquatiques. Par rapport aux conditions existantes, la plus grande fréquence d'ammoniaque libre surviendrait principalement au moment où le débit est le moins élevé, en été et en automne.

Si l'on ne compense pas l'habitat perdu ou dégradé, les volumes annuels d'eau moins élevés que par le passé et la baisse de la qualité des eaux donneraient lieu à une réduction générale de la valeur des zones de pêche au Manitoba. On prévoit un impact sur les pêcheries manitobaines les années d'inondation, lorsque le débit de pointe de crue serait moins élevé mais se maintiendrait plus longtemps. Cela pourrait avoir des effets néfastes sur le frai du grand brochet et de la perche. Aucune mesure d'atténuation n'a été proposée.

Le Projet ne devrait pas entraîner de répercussions importantes sur la productivité de la sauvagine dans la portion manitobaine du bassin de la rivière Souris. D'autres études doivent être entreprises pour confirmer cette supposition.

Au Manitoba, dans les régions en aval, des plantes rares subiraient les effets de la modification des débits de la rivière Souris mais on ignore dans quelle mesure.

À cause du Projet, il y aurait des répercussions modérées au Manitoba dues à l'augmentation d'inondations de terres agricoles à certains endroits, à la productivité plus grande des cours d'eau, aux dépassements de l'objectif de la province en matière d'ammoniaque libre, à la réduction du frai et aux effets négatifs sur les espèces rares de plantes. La plupart de ces effets peuvent être atténués, tandis que l'impact sur les pêcheries n'est pas totalement connu. Quelques incertitudes existent également quant aux effets sur les espèces rares de plantes.

Manque d'information

Au cours de la préparation de l'EEI, on s'est appuyé principalement sur la documentation considérable rassemblée au préalable par le promoteur du Projet (SBDA), par d'autres organismes de la province de la Saskatchewan, par des organismes fédéraux et d'état aux États-Unis, par des organismes du Manitoba, par Environnement Canada et par d'autres ministères fédéraux. On a rassemblé quelques données et des informations supplémentaires dans le domaine de l'hydrologie, de la qualité des eaux, des espèces rares et menacées et des oiseaux migrateurs. Le manque de données et d'information sur quelques secteurs d'intérêt limite la mesure dans laquelle les effets du Projet peuvent être évalués. Les lacunes principales sont classées ci-après comme étant importantes ou moyennes.

LACUNES IMPORTANTES

- Les données de base de 1974 à 1981 pour la Saskatchewan devraient être revues. Les données hydrologiques pour la Saskatchewan, le Dakota du Nord et le Manitoba devraient être mises à jour jusqu'à 1988, y compris les données portant sur les utilisations d'eau actuelles et proposées. Ces données ne sont pas indispensables à la détermination des répercussions générales du Projet, mais elles sont critiques pour l'élaboration d'un plan de gestion de l'eau.

- Les critères de fonctionnement utilisés dans le modèle hydrologique évoluent constamment depuis la préparation par la SBDA de son étude des incidences environnementales. Un plan de gestion de l'eau devrait être élaboré qui inclura l'exploitation du Projet par la Saskatchewan et l'exploitation des refuges fauniques nationaux du Dakota du Nord, et qui tiendra compte des droits du Manitoba.

- Il n'existe pas d'objectifs internationaux de qualité des eaux par rapport auxquels pourraient être mesurés les impacts sur la qualité de l'eau passant la frontière. Si le Projet est poursuivi, il faudra procéder immédiatement à l'élaboration des objectifs internationaux de la qualité des eaux pour les paramètres considérés comme les plus susceptibles d'être affectés.

- Les études sur les incidences environnementales de la SBDA et du U.S. Army Corps of Engineers ne tiennent pas compte des répercussions globales du Projet et du projet du bassin de la rivière Souris sur la qualité de la rivière Souris à la frontière entre le Dakota du Nord et le Manitoba.

- L'exploitation des refuges fauniques nationaux au Dakota du Nord influe sur la qualité de l'eau à la frontière de cet État et du Manitoba. Pour évaluer les conséquences sur la qualité de l'eau et les possibilités d'atténuation, il faudra établir un plan d'exploitation détaillé.

- Des plans détaillés d'atténuation et de contrôle relatifs à la productivité de la sauvagine sont nécessaires avant qu'on puisse prendre une décision quant au sort du Projet.

- Les données sur l'habitat des poissons dans la rivière Souris au Manitoba ne sont pas suffisantes. En outre, on ne connaît pas l'impact du lac Darling et de sa population de poissons sur les régions en aval, au Manitoba. Ces renseignements sont nécessaires pour pouvoir prédire de façon précise les répercussions qu'aura le Projet sur les poissons et déterminer les options de compensation adéquates pour faire en sorte qu'il n'y ait aucune perte nette en habitat de poissons.

- On ne dispose pas de données et de renseignements suffisants pour mener à bien des évaluations comparées de la qualité de l'habitat dans le secteur inondé et la région avoisinante pour ce qui est de la valeur fourragère et de nidification pour la buse rouilleuse.

- La distribution et la richesse des espèces de plantes rares dans la plaine alluviale de la rivière Souris en Saskatchewan et au Manitoba devraient être étudiées plus en détail. L'accent devrait être placé particulièrement sur les régions qui seront inondées par les réservoirs Rafferty et Alameda.

LACUNES MOYENNES

- La régénérescence de la rivière Souris en aval du Projet due aux crues du printemps serait réduite par rapport aux conditions actuelles. On ne sait pas comment les effets de cette réduction se manifesteraient dans l'écosystème aquatique.

- Les modèles de qualité de l'eau utilisés par le promoteur n'ont pas été complètement testés sur le terrain, calibrés ou vérifiés dans le bassin de la rivière Souris, bien que certains essais aient été effectués en 1989. Cette lacune met en doute les résultats obtenus.

- Des données devraient être recueillies sur la répartition des types d'habitat de sauvagine riveraine et terrestre, et sur l'importance et la composition des populations de gibier d'eau se reproduisant sur les rives de la rivière Souris, au Manitoba. Ces données sont nécessaires pour appuyer l'hypothèse selon laquelle le Projet ne nuira pas à la reproduction de la sauvagine le long de cette rivière au Manitoba.

- On manque d'informations quantitatives de base sur la situation du bruant de Baird dans la vallée de la Souris, particulièrement à proximité de l'emplacement des barrages Rafferty et Alameda.

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TABLE OF CONTENTS

		Page
Executive Summary		i
Sommaire Administratif		xi
Acknowledgements		xxiv
List of Tables		xx
List of Figures		xxiv
1 INTRODUCTION		1-1
1.1	The Issue	1-1
1.2	Background	1-2
1.3	Federal Responsibilities	1-4
1.4	The Environmental Assessment and Review Process	1-7
1.5	The Initial Environmental Evaluation	1-9
1.5.1	Preparation of the Initial Environmental Evaluation	1-10
1.5.2	Sources of Information	1-10
2 PUBLIC INPUT		2-1
2.1	Introduction	2-1
2.2	History of Public Involvement and Opinion	2-1
3 PROJECT PROPOSAL		3-1
3.1	General Layout	3-1
3.1.1	Rafferty Dam and Reservoir	3-1
3.1.2	Rafferty-Boundary Division Channel	3-1
3.1.3	Downstream Channelization	3-3
3.1.4	Alameda Dam and Reservoir	3-4
3.2	Construction Details	3-4
3.2.1	Construction Scheduling	3-4
3.2.2	Construction Methods and Sources of Material	3-6
3.2.2.1	Rafferty Dam and Facilities	3-6
3.2.2.2	Rafferty - Boundary Diversion Channel	3-6
3.2.2.3	Downstream Channelization	3-7
3.2.2.4	Alameda Dam	3-7
3.2.3	Reservoir Filling Plan	3-7
4 PROJECT SETTING		4-1
4.1	The Souris River Basin	4-1
4.1.1	Physiography	4-1
4.1.2	Climate	4-1
4.1.3	Vegetation	4-3
4.1.4	Population	4-3
4.1.5	Recreation	4-3
4.1.6	Water Use	4-4
4.1.6.1	General	4-4
4.1.6.2	Saskatchewan	4-4
4.1.6.3	North Dakota	4-9
4.1.6.4	Manitoba	4-14

TABLE OF CONTENTS (Continued)

Page

4.1.7 Flooding 4-14
4.1.8 Energy Resource 4-15
4.1.9 Landuse 4-15
4.2 Associated Projects 4-17
4.2.1 General 4-17
4.2.2 Shand Thermal Generating Station 4-18
4.2.3 Boundary Dam 4-18
4.2.4 Irrigation Development 4-19
4.2.5 Recreation/Tourism Facilities 4-19
4.2.6 Souris River Basin Project (North Dakota) 4-21
4.3 Alternatives 4-22
4.3.1 Flood Damage Reduction 4-22
4.3.2 Water Supply 4-22
4.3.3 Operating Plan Alternatives 4-23

5 INTERNATIONAL WATERS - HYDROLOGY 5-1
5.1 Introduction 5-1
5.2 Existing Conditions 5-3
5.2.1 Saskatchewan 5-3
5.2.2 North Dakota 5-6
5.2.3 Manitoba 5-6
5.3 Project Impacts 5-10
5.3.1 Operation Plan 5-10
5.3.2 Saskatchewan 5-11
5.3.2.1 Filling of Rafferty and Alameda Reservoir 5-20
5.3.2.2 Ground Water 5-20
5.3.3 North Dakota 5-24
5.3.4 Manitoba 5-26
5.4 Mitigation of Project Impact in Saskatchewan, North Dakota and Manitoba 5-37
5.5 Summary 5-37

6 INTERNATIONAL WATERS - WATER QUALITY 6-1
6.1 Existing Conditions 6-1
6.1.1 General 6-1
6.1.2 Information Sources and Data Handling 6-1
6.1.3 Land and Water-based Activities Affecting Existing Quality 6-3
6.1.4 Water Quality Characteristics 6-5
6.1.4.1 Physical Parameters 6-5
6.1.4.2 General Aquatic Health Indicators 6-6
6.1.4.3 Dissolved Solids 6-12
6.1.4.4 Sodium Adsorption Ratio, Boron and Selenium 6-18
6.1.4.5 Metals 6-18
6.1.4.6 Pesticides 6-20
6.1.4.7 Biology 6-20
6.1.5 Overview Statement 6-22
6.2 Project Impacts 6-27

TABLE OF CONTENTS (Continued)

Page

6.2.1 General 6-27
6.2.1.1 What Constitutes an Impact on Water Quality 6-27
6.2.1.2 Factors Influencing Water Quality 6-28
6.2.2 Saskatchewan 6-31
6.2.2.1 Reservoirs 6-31
6.2.2.2 Souris River and Moose Mountain Creek 6-41
6.2.3 North Dakota 6-42
6.2.3.1 International Boundary to Lake Darling 6-42
6.2.3.2 Lower Souris and J. Clark Salyer NWR 6-51
6.2.4 Manitoba 6-56
6.2.4.1 Water Quality - River Flow Relationship 6-56
6.2.4.2 Water Quality Predictive Capability 6-65
6.2.4.3 Irrigation Effects 6-66
6.2.4.4 Mercury 6-66
6.2.4.5 North Dakota Water Management - Induced Effects 6-67
6.3 Overview Statement 6-67
6.3.1 Saskatchewan 6-67
6.3.2 North Dakota 6-70
6.3.3 Manitoba 6-71
6.4 Mitigation of Project Impacts 6-72
6.4.1 Saskatchewan 6-72
6.4.2 North Dakota 6-73
6.4.3 Manitoba 6-74
6.5 Residual Impacts 6-74
6.5.1 Saskatchewan 6-74
6.5.2 North Dakota 6-75
6.5.3 Manitoba 6-75
6.6 Information Deficiencies 6-75
6.6.1 Information Deficiencies of High Significance 6-75
6.6.2 Information Deficiencies of Moderate Significance 6-76
6.6.3 Information Deficiencies of Low Significance 6-77

7 MIGRATORY BIRDS 7-1
7.1 Introduction 7-1
7.2 Migratory Birds Convention 7-1
7.3 North American Waterfowl Management Plan 7-1
7.4 Existing Migratory Birds and Habitat 7-4
7.4.1 Saskatchewan 7-4
7.4.2 North Dakota 7-10
7.4.3 Manitoba 7-11
7.5 Impact of the Project on Migratory Birds 7-14
7.5.1 Introduction 7-14
7.5.2 Saskatchewan 7-15
7.5.2.1 Reservoir Impacts 7-15
7.5.2.2 Channelization Impacts 7-19
7.5.2.3 Drainage Impacts 7-19

TABLE OF CONTENTS (Continued)

Page

7.5.2.4 Waterfowl Concentration Impacts 7-21
7.5.2.5 Impacts on Moose Mountain Creek NWA 7-22
7.5.2.6 Net Impacts in Saskatchewan 7-22
7.5.3 North Dakota 7-22
7.5.4 Manitoba 7-24
7.5.5 Summary of Impacts 7-24
7.6 Mitigation 7-26
7.6.1 Mitigation 7-26
7.6.2 Monitoring 7-26

8 FISH AND FISH HABITAT 8-1
8.1 Mandate 8-1
8.2 The Existing Fishery Resources 8-1
8.2.1 Saskatchewan 8-1
8.2.1.1 Distribution and Relative Abundance 8-3
8.2.1.2 Factors Affecting Populations 8-8
8.2.1.3 Recreational Fisheries 8-10
8.2.2 North Dakota 8-11
8.2.3 Manitoba 8-14
8.3 Project Impact 8-18
8.3.1 Saskatchewan 8-18
8.3.1.1 Fish Movements 8-19
8.3.1.2 Fish Habitat 8-20
8.3.1.3 Effects of Reservoir Filling and Operation 8-21
8.3.1.4 Water Quality 8-21
8.3.1.5 Mercury in Fish 8-22
8.3.2 North Dakota 8-23
8.3.2.1 Hydrology 8-24
8.3.2.2 Flood Operations 8-26
8.3.2.3 Water Quality 8-27
8.3.2.4 Carp Introduction 8-28
8.3.3 Manitoba 8-28
8.3.3.1 Hydrology 8-29
8.3.3.2 Flood Operations 8-30
8.3.3.3 Water Quality 8-31
8.4 Mitigation 8-32
8.4.1 Saskatchewan 8-32
8.4.2 North Dakota 8-33
8.4.3 Manitoba 8-34
8.5 Residual Impacts 8-36
8.5.1 Saskatchewan 8-36
8.5.2 North Dakota 8-36
8.5.3 Manitoba 8-36

9. FEDERAL LANDS 9-1
9.1 Description of Federal Lands 9-1
9.1.1 Federal Lands in the Souris River Basin 9-1

TABLE OF CONTENTS (Continued)

		Page
9.1.2	Federal Lands Directly Impacted by the Project	9-2
9.1.2.1	Location	9-3
9.1.2.2	Land Ownership and Agreements with the Province	9-3
9.1.2.3	Topography	9-3
9.1.2.4	Soils and Vegetation	9-5
9.1.2.5	Land Use	9-5
9.1.2.6	Carrying Capacity	9-5
9.1.2.7	Improvements	9-5
9.1.2.8	Economic Value	9-6
9.2	Project Impacts	9-6
9.2.1	Estevan - Cambria Community Pasture	9-6
9.2.1.1	Loss of Land	9-6
9.2.1.2	Loss of Access	9-6
9.2.1.3	Impact of Loss on Carrying Capacity and Access	9-6
9.2.1.4	Economic Impact	9-6
9.2.2	Lomond #1 Community Pasture	9-7
9.2.2.1	Loss of Land	9-7
9.2.2.2	Loss of Access	9-7
9.2.2.3	Impact of Loss on Carrying Capacity	9-7
9.2.2.4	Impact of Loss of Access Within the Pasture	9-8
9.2.2.5	Economic Impact	9-8
9.2.3	Impact on Downstream Federal Properties	9-8
9.3	Mitigation	9-8
9.3.1	Estevan-Cambria Pasture	9-9
9.3.1.1	Mitigation for Loss of Land	9-9
9.3.1.2	Mitigation of Loss of Access	9-9
9.3.1.3	Other Mitigation Measures	9-9
9.3.1.4	Impact of Mitigation	9-10
9.3.2	Lomond #1 Community Pasture	9-10
9.3.2.1	Mitigation for Loss of Land	9-10
9.3.2.2	Mitigation for Loss of Access	9-10
9.3.2.3	Other Mitigation Measures	9-10
9.3.2.4	Impact of the Mitigation Measures	9-10
10	RARE AND ENDANGERED FLORA AND FAUNA	10-1
10.1	Introduction	10-1
10.2	Definitions of Status	10-1
10.3	Rare, Endangered and Threatened Bird and Mammal Species	10-2
10.3.1	Distribution and Existing Habitat - Saskatchewan and Manitoba	10-2
10.3.1.1	Peregrine Falcon	10-2
10.3.1.2	Loggerhead Shrike	10-2
10.3.1.3	Cooper's Hawk and Great Grey Owl	10-4
10.3.1.4	Whooping Crane	10-4
10.3.1.5	Piping Plover	10-4
10.3.1.6	Baird's Sparrow	10-5
10.3.1.7	Burrowing Owl	10-5

TABLE OF CONTENTS (Continued)

Page

10.3.1.8 Ferruginous Hawk 10-6
10.3.1.9 Eastern Bluebird 10-6
10.3.1.10 Prairie Long-Tailed Weasel 10-7
10.3.2 North Dakota 10-7
10.3.3 Impacts of the Project 10-7
10.3.3.1 Introduction 10-7
10.3.3.2 Saskatchewan 10-8
10.3.3.3 North Dakota 10-10
10.3.3.4 Manitoba 10-10
10.3.4 Summary of Impacts 10-11
10.3.5 Mitigation and Monitoring 10-11
10.3.5.1 Saskatchewan 10-11
10.3.5.2 North Dakota 10-12
10.3.5.3 Manitoba 10-12
10.3.6 Residue Impacts 10-12
10.3.6.1 Saskatchewan 10-12
10.3.6.2 North Dakota 10-12
10.3.6.3 Manitoba 10-12
10.3.7 Information Deficiencies 10-12
10.3.7.1 Saskatchewan 10-12
10.3.7.2 North Dakota 10-13
10.3.7.3 Manitoba 10-13
10.4 Rare Plant Species 10-13
10.4.1 Saskatchewan 10-13
10.4.2 North Dakota 10-22
10.4.3 Manitoba 10-22
10.4.4 Souris Valley Plants Rare to Canada as a Whole 10-32
10.4.5 Impacts on Plants of National Interest 10-35
10.4.6 Implications of Population Changes on Extermination of Plant Species 10-37
10.4.7 Mitigation 10-37
10.4.8 Information Deficiencies 10-37

11 NAVIGABLE WATERS PROTECTION 11-1
11.1 Existing Environment 11-1
11.2 Project Impacts 11-1
11.3 Mitigation Measures 11-2

12 SUMMARY 12-1
12.1 General 12-1
12.2 Overview of Environmental Impacts, Mitigation, and Information Deficiencies 12-2
12.3 Water Quantity 12-5
12.3.1 Project Impacts 12-5
12.3.2 Mitigation of Project Impacts 12-6
12.3.3 Residual Impacts 12-7
12.3.4 Information Deficiencies 12-7

TABLE OF CONTENTS (Continued)

Page

12.4 Water Quality 12-8
12.4.1 Project Impacts 12-8
12.4.2 Mitigation of Project Impacts 12-10
12.4.3 Residual Impacts 12-12
12.4.4 Information Deficiencies 12-13
12.5 Migratory Birds 12-14
12.5.1 Project Impacts 12-14
12.5.2 Mitigation of Project Impacts 12-15
12.5.3 Residual Impacts 12-15
12.5.4 Information Deficiencies 12-15
12.6 Fish and Fish Habitat 12-16
12.6.1 Project Impacts 12-16
12.6.2 Mitigation of Project Impacts 12-17
12.6.3 Residual Impacts 12-18
12.6.4 Information Deficiencies 12-18
12.7 Federal Lands 12-18
12.7.1 Project Impacts 12-19
12.7.2 Mitigation of Project Impacts 12-19
12.7.3 Residual Impacts 12-19
12.7.4 Information Deficiencies 12-19
12.8 Rare and Endangered Species 12-19
12.8.1 Rare and Endangered Fauna 12-19
12.8.1.1 Project Impacts 12-20
12.8.1.2 Mitigation of Project Impacts 12-21
12.8.1.3 Residual Impacts 12-22
12.8.1.4 Information Deficiencies 12-22
12.8.2 Rare Flora 12-23
12.8.2.1 Project Impacts 12-23
12.8.2.2 Mitigation of Project Impacts 12-24
12.8.2.3 Residual Impacts 12-24
12.8.2.4 Information Deficiencies 12-24
12.9 Navigable Waters Protection 12-24
12.9.1 Project Impacts 12-24
12.9.2 Mitigation of Project Impacts 12-25
12.9.3 Residual Impacts 12-25
12.9.4 Information Deficiencies 12-25
12.10 Conclusions 12-25

13 RESPONSE TO ISSUES RAISED THROUGH THE PUBLIC REVIEW PROCESS 13-1
13.1 Introduction 13-1
13.2 Issues Raised and Response 13-1
13.2.1 Role of an IEE as Opposed to an Environmental Impact Statement 13-1
13.2.2 Scoping Procedure for the Initial Environmental Evaluation 13-2

TABLE OF CONTENTS (Continued)

		Page
13.2.3	Independent Review	13-3
13.2.4	Alameda Environmental Impact Assessment	13-3
13.2.5	Basin wide Assessment	13-3
13.2.6	Water Scarcity in the Souris River Basin	13-4
13.2.7	Drought Proofing	13-5
13.2.8	Flood Control	13-5
13.2.9	Ground Water Pumping - Rafferty Reservoir	13-6
13.2.10	Project Alternatives	13-6
13.2.11	Economic Feasibility	13-7
13.2.12	Sustainable Development	13-7
13.2.13	Regional and Economic Development, and Water Management Benefits of the Project	13-8
13.2.14	Public Information	13-8
13.2.15	Water Export, Interbasin Diversion, and Free Trade	13-9
13.2.16	The 1959 Interim Measures	13-10
13.2.17	Requirement for a Souris Basin-wide Management Plan	13-12
13.2.18	Operation of the National Wildlife Refuges	13-12
13.2.19	Evaluation of the Effects of the Project and U.S. Works on Manitoba	13-12
13.2.20	North American Waterfowl Management Plan	13-14
13.2.21	Waterfowl Impacts/Mitigation	13-15
13.2.22	Wetland Drainage	13-15
13.2.23	Scope of Migratory Birds Assessment	13-16
13.2.24	Navigable Waters	13-16

Cited References 14-1

Annex 1 - Metric Conversion Table 15-1

Annex 2 - List of Acronyms Used 15-2

LIST OF TABLES

		Page
3.1	Rafferty Reservoir Characteristics	3-3
3.2	Alameda Reservoir Characteristics	3-4
3.3	Construction Schedule	3-6
4.1	Summary of Licensed Water Uses - 1985 (dam^3) Located in the Effective Drainage Area Souris River Basin	4-5
4.2	Major Water Development Projects Existing in Saskatchewan	4-11
4.3	Water Management Structures in the Souris River Basin in North Dakota	4-12
4.4	Water Management Structures in the Souris River Basin in Manitoba	4-17
4.5	Proposed Level of Irrigation Development in Saskatchewan	4-20
4.6	Visitation to Existing and Proposed Recreation Area	4-21
5.1	Mean Flows for Sherwood	5-12
5.2	Sherwood - Flow - Simulated Historic (J55A)	5-17
5.3	Sherwood - Flow Project (E55A)	5-18
5.4	Sherwood - Flow Difference (E55A-J55A)	5-19
5.5	Sherwood - Flow Difference (C51A12-C51A)	5-23
5.6	Annual Low Flow Duration - Souris River at Sherwood (1931-1974)	5-25
5.7	Mean Flows for Westhope	5-31
5.8	Westhope Flow - Simulated Historic (J55A)	5-33
5.9	Westhope Flow - Project E55A	5-34
5.10	Westhope Flow - Difference (E55A-J55A)	5-35
5.11	Annual Low Flow Duration - Souris River at Westhope (1931-1974)	5-36
5.12	Rafferty/Alameda Damage Increment Summary in 1982 Dollars	5-36

LIST OF TABLES (Continued)

Page

6.1 Souris River Basin Water Quality Information Locations 6-1

6.2 Point Source Discharges to the Souris River 6-4

6.3 Summary of Water Quality Data for Selected Parameters, Glen Ewen, Saskatchewan and Coulter, Manitoba 6-7

6.4 Seasonal Summary of Selected Parameters for Glen Ewen and Coulter Median, (Range), Sample Site 6-8

6.5 Water Quality Summary of Selected Parameters for Moose Mountain Creek and Souris River at Glen Ewen 6-16

6.6 Seasonal Summary of Selected Parameters for Moose Mountain Creek, Median, (Range), Sample Size 6-17

6.7 Relative Abundance of Anions in Moose Mountain Creek and Souris River Waters 6-19

6.8 Bacteriological Quality of International Waters 6-21

6.9 Exceedances of Guidelines, Objectives and Standards at Glen Ewen and Coulter 6-23

6.10 Project Induced Flow Changes at Saskatchewan-North Dakota Boundary 6-45

6.11 Project Induced Flow Changes at North Dakota-Manitoba Boundary 6-58

6.12 Summary of Projected Long Term Water Quality Impacts - Souris River at the Saskatchewan - North Dakota Boundary, Relative to Existing Water Quality 6-68

6.13 Summary of Projected Long Term Water Quality Impacts - Souris River at the North Dakota - Manitoba Boundary, Relative to Existing Water Quality 6-69

7.1 Population Densities of Mallards, Northern Pintail and Blue-winged Teal in Southern Saskatchewan in 1976 and 1986 7-6

7.2 Duck Production Estimates for the Rafferty Project Area on Souris River System, 1984 7-7

7.3 Duck Production According to Shoreline Habitat Characteristics in the Proposed Rafferty Reservoir Area, 1987 7-8

LIST OF TABLES (Continued)

		Page
7.4	Numbers of Duck Broods in the Proposed Rafferty Reservoir Area, 1987	7-9
7.5	Duck Production in the Proposed Alameda Reservoir Area, 1987	7-10
7.6	Numbers of Duck Indicated Breeding Pairs and Broods in the Proposed Alameda Reservoir Area, 1987	7-10
7.7	Average Duck Production Estimates for Upper Souris and J. Clark Salyer National Wildlife Refuges, 1959-1978	7-12
7.8	Waterfowl Observed Along the Souris River in Manitoba in 1976	7-13
7.9	Potential Duck Production from Rafferty and Alameda Reservoirs	7-19
7.10	Summary of Projected Impacts of the Project on Waterfowl	7-25
8.1	Scientific and Common Names of Fishes Reported From the Souris River Basin in Saskatchewan	8-2
8.2	Distribution of Fish Species within the Souris River Mainstem Downstream of Weyburn	8-3
8.3	Distribution of Fish Species Within Moose Mountain Creek	8-4
8.4	Scientific and Common Names of Fishes Reported from the Souris River Basin in Manitoba	8-16
9.1	Federal Departmental Land Holdings Within the Souris River Basin	9-1
10.1	Birds and Mammals	10-3
10.2	Saskatchewan List of Rare Plants in the Souris Basin	10-14
10.3	Saskatchewan Localities of Rare Plants in the Souris Basin	10-16
10.4	Canadian Distribution of Saskatchewan Rare Plants from the Souris Basin	10-17
10.5	United States Distribution of Saskatchewan Rare Plants from the Souris Basin	10-19
10.6	Habitat of Saskatchewan Rare Plants from the Souris Basn	10-21

LIST OF TABLES (Continued)

Page

10.7 North Dakota List of Rare Plants in the Souris Basin 10-23

10.8 Manitoba List of Rare Plants in the Souris Basin 10-24

10.9 Manitoba Localities of Rare Plants in the Souris Basin 10-25

10.10 Canadian Distribution of Manitoba Rare Plants from the Souris Basin 10-27

10.11 Central United States Distribution of Manitoba Rare Plants from the Souris Basin 10-29

10.12 Habitat of Manitoba Rare Plants from the Souris Basin 10-31

12.1 Summary of Adverse Environmental Impacts Caused by Altered Flows and Lake Levels 12-2

12.2 Summary of Information Deficiencies 12-4

LIST OF FIGURES

		Page
3.1	Location Map: Rafferty Dam, Diversion Channel, Downstream Channelization and Shand Power Plant	3-2
3.2	Location Map: Alameda Reservoir	3-5
4.1	Souris River Basin Map	4-2
4.2	Annual Distribution of Municipal Water Consumption - Estevan and Weyburn	4-6
4.3	Annual Average Water Demand - Estevan and Weyburn	4-7
4.4	Historical Trends in Annual Water Demand - Estevan	4-8
4.5	Souris River Basin Saskatchewan	4-10
4.6	Souris River Basin North Dakota	4-13
4.7	Souris River Basin Manitoba	4-16
5.1	Recorded Mean Monthly Flow - Souris River near Roche Percee and near Sherwood	5-4
5.2	Recorded Mean Monthly Flow - Moose Mountain Creek near Oxbow and Souris River near Westhope	5-5
5.3	Recorded Flood Hydrographs - Souris River near Roche Percee and near Sherwood	5-7
5.4	Recorded Flood Hydrographs - Moose Mountain Creek near Oxbow and Souris River near Westhope	5-8
5.5	Map of Souris River, North Dakota	5-9
5.6	Rafferty Reservoir Levels E55A	5-13
5.7	Alameda Reservoir Levels E55A	5-14
5.8	Discharge Comparison Souris River at Sherwood	5-15
5.9	Rafferty Reservoir, Filling Scenarios	5-21
5.10	Alameda Reservoir, Filling Scenarios	5-22
5.11	Flow Duration Curve, Souris River near Sherwood	5-28
5.12	Souris River at Westhope, 1969 Flood	5-29

LIST OF FIGURES (Continued)

		Page
5.13	Souris River at Westhope, 1975 Flood	5-30
5.14	Average Flows at Westhope	5-32
5.15	Flow Duration Curve, Westhope	5-38
6.1	Water Quality Sampling Locations	6-2
6.2(a)	Phosphorus Loading at Glen Ewen and Coulter	6-10
6.2(b)	Nitrogen Loading in Souris River at Glen Ewen and Coulter	6-11
6.3	Total Ammonia vs Toxic Level of Ammonia at Coulter	6-13
6.4(a)	Water Quality Ranges for Selected Parameters	6-14
6.4(b)	Water Quality Ranges for Selected Parameters	6-15
6.5	Rafferty Reservoir - TDS	6-33
6.6	Rafferty Reservoir - Volume	6-34
6.7	Zero Flow Frequency Distribution at Sherwood	6-43
6.8(a)	Souris River at Sherwood: Historical and Projected Flows 1922 (Average Year)	6-46
6.8(b)	Souris River at Sherwood: Historical and Projected Flows 1937 (Dry Year)	6-47
6.8(c)	Souris River at Sherwood: Historical and Projected Flows 1955 (Wet Year)	6-48
6.8(d)	Souris River at Sherwood: Historical and Projected Flows 1965 (Average Year)	6-49
6.9(a)	Souris River at Minot: Historical and Projected Flows 1922 (Average Year)	6-52
6.9(b)	Souris River at Minot: Historical and Projected Flows 1937 (Dry Year)	6-53
6.9(c)	Souris River at Minot: Historical and Projected Flows 1955 (Wet Year)	6-54

LIST OF FIGURES (Continued)

		Page
6.9(d)	Souris River at Minot: Historical and Projected Flows 1965 (Average Year)	6-55
6.10(a)	Souris River at Westhope: Historical and Projected Flows 1922 (Average Year)	6-59
6.10(b)	Souris River at Westhope: Historical and Projected Flows 1937 (Dry Year)	6-60
6.10(c)	Souris River at Westhope: Historical and Projected Flows 1955 (Wet Year)	6-61
6.10(d)	Souris River at Westhope: Historical and Projected Flows 1965 (Average Year)	6-62
6.11	Zero Flow Frequency Distribution at Westhope	6-63
7.1	Moose Mountain Upland, Key Program Area (NAWMP)	7-3
7.2	CLI Waterfowl Classification for the Souris Basin in Saskatchewan	7-5
9.1	PFRA Community Pastures	9-4

1 INTRODUCTION

1.1 The Issue

The province of Saskatchewan began detailed planning for the Rafferty-Alameda Project (henceforth referred to as the Project) in 1984. The major components of the Project include the construction of two dams creating the Rafferty Reservoir on the Souris River near Estevan and the Alameda Reservoir on Moose Mountain Creek, a tributary of the Souris, near Oxbow. Other project components in Saskatchewan include the construction of a channel connecting the existing Boundary Reservoir and the proposed Rafferty Reservoir, and channelization downstream of Rafferty Dam. On February 12, 1986, the province announced commencement of the project subject to compliance with all federal and provincial environmental and regulatory requirements, approvals and licences.

The Souris River basin encompasses various federal responsibilities pertaining to international waters and other federal interests, which include fisheries, migratory birds, navigable waters, and federal lands. The International River Improvements Act (IRIA), administered by Environment Canada, requires an application for a licence for any proposed works affecting an international river.

On January 7, 1988 the Saskatchewan Water Corporation (Sask Water) applied for a licence to build and operate the Project under the provisions of the IRIA. The licence was issued to the province on June 17, 1988, conditional on compliance with certain requirements attached to the licence. These requirements, when met, would satisfy concerns for matters of federal responsibility. Environment Canada reviewed the Project Proponent's (Souris Basin Development Authority - SBDA) Environmental Impact Statement (EIS) to address federal interests through the provincial environmental assessment process prior to issuing the licence.

Mr. Justice Bud Cullen of the Federal Court of Canada quashed the IRIA licence on April 10, 1989 and ordered compliance with the federal Environmental Assessment and Review Process (EARP) Guidelines Order in considering the application by Sask Water for a licence. The Court's decision was based on its interpretation of responsibilities set out in the Guidelines Order.

In the ruling, the Court considered the Project to be an "international river improvement", and the Souris River to be an "international river." Furthermore the Court defined the Guidelines Order applicable "to any proposal" having "an environmental effect on an area of federal responsibility." Issuing a licence under the IRIA for the Project constituted a "decision making responsibility." Areas of federal responsibility were considered to be: international relations, transboundary water flows (Boundary Waters Treaty), migratory birds, interprovincial affairs, fisheries and federal lands.

The Minister of the Environment, on April 12, 1989, in response to the Federal Court Order, directed his officials to apply the EARP to those areas of federal interest related to the Project as specified by the Court. In keeping with those instructions, the EARP was initiated at the initial assessment phase by preparing an Initial Environmental Evaluation (IEE). The draft IEE would delineate the environmental impacts of the Project on areas of federal interest and identify the potential for mitigation of these effects.

The Minister also required that public review of the draft IEE through public meetings be included as part of the process. The final draft of the IEE and its recommendations to the Minister would thus directly incorporate the concerns of the public.

1.2 Background

Since the beginning of homesteading in the Souris basin, alternate periods of flood and drought have been a point of concern for settlers, who viewed management of an erratic water supply as the key to economic prosperity. To this end, water storage and distribution structures on the Souris River were envisaged in the early 1900s. Although a dam on Moose Mountain Creek had been suggested as early as 1907, proposals on the scale of the Rafferty-Alameda Project did not receive serious consideration until the drought-stricken 1930s.

Major water resource management studies on the Souris River system were regulated by governments and initiated by the International Joint Commission (IJC) in 1940 and 1957 and were followed with a water apportionment agreement in 1959. In the 1970s, the Souris River Basin Study, conducted jointly by the governments of Saskatchewan, Manitoba and Canada, concluded that a viable project involving reservoir storage on the Souris River in Saskatchewan could only be realized in conjunction with a new, major industrial use.

In 1984, the province of Saskatchewan began planning for a Rafferty-Alameda Project with the Saskatchewan Power Corporation (SPC) acting as the primary proponent. The SPC considered several alternatives for increasing electric generating capacity in the province and chose a proposed 600 megawatt (MW) thermal electric generating station in the Estevan area, with the Rafferty Dam and Reservoir as the source of cooling water.

The Project also included major flood control components for North Dakota, since Saskatchewan had initiated discussions with U.S. authorities to assess the feasibility of a jointly funded project. The U.S. Army Corps of Engineers subsequently conducted studies into flood control benefits that could accrue, primarily to the city of Minot, from an enlarged Rafferty project. In late 1984 and early 1985, Canadian federal departments, including Environment Canada and External Affairs, were contacted by Sask Water to discuss federal assistance and the necessary interjurisdictional approvals.

Environment Canada registered the project in 1985 with the Regional Screening and Coordinating Committee (RSCC) to review the environmental aspects of the project. The RSCC has membership from Environment Canada, as well as the federal departments of Fisheries and Oceans (DFO) and Agriculture (Canadian Forestry Service). This Committee concluded that a review of pertinent Project-related documents should be carried out from a federal standpoint.

The multi-purpose $120 million Rafferty-Alameda Project, which now included provisions for recreation and irrigation potential in Saskatchewan, was announced on February 12, 1986, pending approval of funding and compliance with all environmental and regulatory requirements. Construction of the $500 million Shand Thermal Generating Station was announced at the same time. The Saskatchewan Power Corporation (SPC) is the responsible provincial agency and proponent for the power plant.

The Souris Basin Development Authority (SBDA), was established as a Crown corporation by the province, (referred to as "the Proponent" in the text), at this time to coordinate and manage the Project. Subsequently, a provincial Board of Inquiry was established for the purpose of examining all environmental aspects of the Project. One of the initial SBDA tasks was the preparation of an Environmental Impact Statement (EIS) for the Project.

Authorization for the U.S. portion of the Project, the Souris River Basin Project, was received by the U.S. Army Corps of Engineers following passage in the U.S. Congress of an Omnibus Water Bill on October 17, 1986. This bill sanctioned a $41 million U.S. contribution towards the Rafferty-Alameda Project.

On July 6, 1987, Environment Canada, through the RSCC, reviewed the draft EIS for the Project and provided comments to Saskatchewan Environment and Public Safety at their request. Comments on the final SBDA EIS were also provided by Environment Canada to that department on September 14, 1987. This federal input to the provincial environmental assessment and review process was deemed appropriate and adequate by Environment Canada for addressing matters of federal interest, and therefore was considered to have met the intent and requirements of the federal EARP Guidelines Order.

In late November 1987, the U.S. Army Corps of Engineers entered a draft EIS into the Public Registry for the North Dakota components of the Project and forwarded copies to Environment Canada in December 1987. Environment Canada's comments on this draft EIS, notably these related to Manitoba's concerns for water quality at the international boundary, were provided to the Corps in January 1988. Since December 1987, ongoing multilateral meetings and negotiations have been held in Ottawa and Washington between the affected provincial, state and federal governments to discuss these and other concerns.

The provincial Board of Inquiry held public meetings at Regina and five centres in the Souris basin in September 1987 and delivered its report to the Saskatchewan Minister of Environment and Public Safety on January 27, 1988. On the basis of the EIS, comments on the EIS and the Board's report, the provincial Minister of the Environment granted conditional approval for the Project. Final approval under the provincial Environmental Assessment Act for construction and operation of the dams and the generating station was given by the provincial Minister of the Environment and Public Safety on February 15 and 16, respectively. Preliminary construction work and site preparation for the Rafferty Dam commenced on March 29, 1988.

Throughout early 1988, Manitoba continued to participate in federal-provincial discussions concerning Manitoba's interests and joined the Canadian negotiations towards a Canada-U.S. Agreement to manage the downstream implications of the Project. North Dakota informed Manitoba in March of 1988 of its intent to meet the terms of Article IV of the Boundary Waters Treaty of 1909. The Canada-U.S. Agreement, although completed, has yet to be ratified.

On January 7, 1988, Sask Water applied to Environment Canada for a licence under the IRIA for construction and operation of the Project. The IRIA licence for the Project was signed by the federal Minister and Sask Water on June 17, 1988.

On July 22, 1986 the U.S. Army Corps of Engineers released the, "General Plan Report and Final Environmental Impact Statement" for the Souris River Basin Project. This report documented the potential environmental implications of the Project including the components of the associated projects in the United States. These components are described in subsection 4.2.6.

On January 19, 1989, the Canadian Wildlife Federation (CWF), G. Geske and J. Dolecki filed an Application in the Federal Court requesting that the IRIA licence be set aside, and that the federal Minister of the Environment comply with the EARP Guidelines Order. A Federal Court of Canada decision, rendered April 10, 1989, quashed the IRIA licence and ordered the immediate application of EARP to the Project as it relates to federal interests in considering an application for a licence under the IRIA.

1.3 Federal Responsibilities

Constitutional Division of Power

Specific clauses in the Constitution assign jurisdiction to the provinces over property, civil rights and the management and sale of public lands within the provinces. Traditionally, water is considered to be a form of property, permitting provincial power over water resources.

The Constitution gives the provinces control over matters of a "local or private nature" and a 1982 Constitutional Amendment provides jurisdiction over electrical generating works. Provincial jurisdiction is limited, however, by specific powers assigned to the federal government.

The Constitution provides for exclusive federal jurisdiction over fisheries, navigation, migratory birds, relations with foreign governments, federal lands, Indians, "works for the general advantage of Canada" and "peace, order and good government".

Navigation

Exclusive federal authority over navigation empowers the government to pass legislation, such as the Navigable Waters Protection Act (NWPA), under which it can regulate activities in navigable waters. The Project does have implications for navigable waters in the basin as defined by the NWPA.

Fisheries

Canada has responsibility for regulation and protection of all fisheries and fish habitat and provides for their management under the federal Fisheries Act. The Act allows for federal regulation and decision making respecting activities that could alter water flows or quality in a way that would harm fish. Federal regulations for the conservation and protection of fishery resources in Saskatchewan and Manitoba are passed by Parliament pursuant to the Fisheries Act and are administered in Saskatchewan and Manitoba by their respective provincial government agencies. The Project could potentially alter fish habitat and change flows and water quality in ways that may affect fish, and thus federal decision-making responsibilities in protecting local fisheries and fish habitat must be exercised.

Federal Lands

Canada has direct responsibility for federal lands. The Prairie Farm Rehabilitation Act, originally passed in 1935 to respond to the prairie drought crisis, empowers the federal government to develop water supplies and promote landuse practices to rehabilitate drought stricken areas in the prairie provinces. Agriculture Canada, through the Prairie Farm Rehabilitation Administration (PFRA), administers programs under the Act for rural water and soil conservation. PFRA pastures, either "owned" or held in trust and administered by Agriculture Canada, are located in the Project area.

International Waters

Canada also has authority for the resolution of transboundary water issues involving waters that straddle or cross jurisdictional boundaries. Canada has legal obligations to the United States under international treaties (Boundary Waters Treaty of 1909) and principles of international law for an equitable sharing of benefits of interjurisdictional watercourses.

The Souris River is an international transboundary river that originates in the province of Saskatchewan, crosses the boundary to North Dakota in the United States and re-enters Canada in Manitoba. Canada's obligations to the United States within the context of international agreements are ensured by application of the IRIA. As the Souris River traverses both the

Saskatchewan-North Dakota and North Dakota-Manitoba boundaries, international treaties and agreements apply.

The Boundary Waters Treaty of 1909 (BWT) sets out the basic principles governing boundary water use and management between Canada and the United States. Article IV prohibits the construction or maintenance of protective works, dams or obstructions in waters flowing from boundary waters, or downstream of the boundary in rivers flowing across the boundary. Projects that would raise water levels in the other country except by mutual agreement are of particular interest. Article IV also states that:

> **"Boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other".**

The International Boundary Waters Treaty Act in Canada implements the 1909 Treaty. Works connected with the Project in Saskatchewan and the Souris River Basin Project in North Dakota must conform to the terms and conditions of the Boundary Waters Treaty. It is Canada's responsibility to ensure that these are met to the mutual satisfaction of the provinces and states involved.

Under the Boundary Waters Treaty, the governments of Canada and the United States established the International Joint Commission to undertake studies and manage agreed arrangements to apportion waters between the two countries. Boards, are appointed to work under the IJC to carry out such activities with technical expertise from federal, state, and provincial governments, as required.

Souris River flows at the two international crossing points are monitored through the International Souris River Board of Control in accordance with the "1959 Interim Measures" established by the governments of Canada and the United States. The Board of Control was established under the International Joint Commission to ensure compliance with the measures that apportion the flows of the Souris River between Saskatchewan, North Dakota, and Manitoba.

International River Improvements Act

In addition to the above international commitments, Canada has responsibilities under the 1955 International River Improvements Act. The IRIA provides the authority for the Minister of the Environment to approve water projects developed upstream from the international boundary in international rivers by issuing either a licence or certificate of exemption. This is to ensure that internationally shared water resources are developed and used in the best national interest. The Act does not apply to international river improvements constructed under the authority of an Act of the Parliament of Canada, or situated within boundary waters as defined in the 1909 Boundary Waters Treaty, or constructed, operated and maintained solely for domestic, sanitary or irrigation purposes.

Under the provisions of the International River Improvements Act Regulations, the Rafferty and Alameda dams do constitute a project requiring application to the federal Minister of the Environment for a licence under the IRIA. The Project requires application since the works are planned for a river that eventually crosses the international boundary, and the works have a use within the purview of the Act.

Migratory Birds

The Convention for the Protection of Migratory Birds was established between the United States and Great Britain (on behalf of Canada) in 1916 to provide the basis for the cooperative conservation of migratory birds between the two nations. In 1917, Parliament passed the Migratory Birds Convention Act, implementing the 1916 convention with the United States and giving Canada powers to protect migratory birds and their habitat. Canada is also a member of the North American Waterfowl Management Plan, a non-regulatory program for protecting waterfowl and their habitats administered by Canada, the United States and Mexico (1936) under the Migratory Birds conventions of 1916 and 1936. Riverine areas such as the Souris Basin provide suitable habitat for waterfowl and other migratory birds.

Natural Resources

In western Canada, the Natural Resources Transfer Agreement of 1930, and its subsequent amendment in 1938, gave the provinces ownership of natural resources including water within their boundaries and hence, the majority of the power to deal with water resources. This authority is however, limited by the existence of specific federal powers in the constitution.

Rare and Endangered Species

Through the Natural Resources Transfer Agreements of 1930, Canada delegated its responsibilities for wildlife resource management to the governments of the western provinces. No federal act exclusively, or by name, relates to endangered species as such. However, provisions in the federal Canada Wildlife Act allow the Minister of the Environment, in cooperation with interested provincial governments, to take the necessary measures to protect species of non-domestic animals in danger of extinction. Canada also provides a Secretariat and is a member of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), a national body that determines the official status of Canadian species at risk and maintains a lead role in the recovery of endangered species through such non-government agencies such as the World Wildlife Fund (Canada).

1.4 The Environmental Assessment and Review Process

The federal Environmental Assessment and Review Process (EARP) originated in a Cabinet Decision in December 1973 and was amended in 1977. The current federal process is contained in the 1984 Guidelines Order promulgated pursuant to the "Government Organization Act" (1979) and later the Department of the Environment Act (2nd supp).

The EARP Guidelines Order was rendered an "enactment" or "Regulation" in the April 10, 1989 Federal Court of Canada decision regarding the Project. As such the guidelines must be applied to any proposal having an environmental effect on an area of federal responsibility. "Proposal" is defined in the Guidelines as "any initiative, undertaking or activity for which the Government of Canada has a decision making responsibility". The issuing of a licence under the IRIA for the Rafferty-Alameda project was deemed by the Court to constitute a "decision making responsibility" that required the application of EARP.

The purpose of the process is to ensure that federal projects, programs and activities or proposals affecting areas of federal responsibility undergo assessment early and throughout their planning stages. This is to ensure that environmental effects are taken into account before decisions are made.

The 1984 Guidelines Order establishes EARP and sets out the necessary requirements and procedures and the responsibilities of the various federal participants. It outlines the basic framework for conducting a systematic and documented assessment of the environmental implications of proposals. As the process is one of self assessment, the initiating department for the proposal is considered the "decision-making authority" that must ensure all environmental implications are adequately assessed.

In this IEE, only concerns related to areas of federal responsibility will be considered. The results of environmental assessments are expected to be incorporated into the planning, decision making and implementation activities associated with the proposal. The EARP requires that proposals also be assessed for social effects directly related to the physical and biological effects. All federal departments and agencies are subject to EARP except proprietary federal Crown corporations and regulatory agencies, and these are invited to participate.

The EARP consists of three phases. It begins with an initial screening which may include the use of automatic exclusion or referral lists and the application of one or more screening techniques to provide a systematic, documented general assessment of environmental implications and the significance of impacts. The key decisions by an initiating agency, following screening, may include:

(a) The project has no significant adverse effects and the project proceeds or adverse effects are mitigable and the project proceeds with modifications;

(b) The potential adverse environmental effects or their mitigability are unknown and further study and a more detailed assessment are required;

(c) The potential adverse environmental effects are significant or there is major public concern and the project is referred to the Minister of the Environment for public review by a Panel; and

(d) The adverse environmental effects are unacceptable in which case the proposal is modified, re-screened, or abandoned.

Decision (b) requires the preparation of an Initial Environmental Evaluation by the proponent.

1.5 The Initial Environmental Evaluation

The Initial Environmental Evaluation (IEE) is the accepted format for documenting the results of investigations conducted beyond the screening stage. The IEE is largely based on an evaluation of existing information. Its general purpose is to provide the initiating department with a more detailed examination from which to determine the potential for adverse environmental effects of a proposal and the suitability of the existing information base.

The IEE should address unknowns or information deficiencies associated with the impacts and mitigation possibilities. It also provides a stronger basis for subsequent decision making regarding the future of the proposal. The possible decisions resulting from the IEE range from proceeding with the Project (in this case by the granting of the IRIA licence) without further study to abandonment of the Project. A number of options, involving additional research, modifications to the project, or referral to an EARP Pannel for public review, fall between these two extremes.

The outline of this IEE follows accepted standard guidelines for conducting initial assessments and the preparation of IEEs developed by the Federal Environmental Assessment and Review Office (FEARO) and Environment Canada (FEARO 1986).

The IEE is organized into several sections under the headings: Project Setting, Project Proposal, Federal Concerns, Summary and Recommendations, and an annexed Bibliography. Federal areas of responsibility are covered under the general subheadings, International Waters - Hydrology, International Waters - Water Quality, Migratory Birds, Fish and Fish Habitat, Federal Lands, Rare and Endangered Flora and Fauna, and Navigable Waters. Discussions pertaining to federal responsibilities focus on the description of the existing resource base, potential impacts of the proposed project, including mitigative procedures, residual impacts, monitoring requirements and information deficiencies.

The document uses SI metric units, and a table of conversion factors to the imperial system is included in Annex 1. A list of acronyms used appears as Annex 2.

1.5.1 Preparation of the Initial Environmental Evaluation

A task force composed of representatives from affected federal departments and led by Environment Canada prepared this IEE. After an informal scoping process to determine the important issues with respect to federal responsibilities, the task force assigned coordinating roles, assessed space and time boundaries for the study and developed an overall study strategy. Communications were initiated with provincial agencies in Saskatchewan and Manitoba, many of which had offered their assistance.

A variety of tools and techniques were employed to fill data gaps and supplement existing information for the IEE. They ranged from simple map overlay techniques to sophisticated computer modelling of anticipated hydraulic conditions. No fixed single standard method is available that enables evaluation of all potential impacts on the environment. Many initial assessment methods are project and problem specific. These are well documented in FEARO, Environment Canada publications and other sources available to the public and are therefore not discussed further.

Upon its completion, the draft IEE was be made available to public interest groups and government agencies for review. Public consultation meetings were held from June 22 to 29, 1989 in Regina, Oxbow and Estevan, Saskatchewan, Melita, Souris and Brandon, Manitoba and Minot, North Dakota. Each meeting consisted of an afternoon open house in which the public was invited to come and discuss the draft IEE and the evening meeting when briefs were presented. In addition, written briefs were accepted until July 10, 1989. Public recommendations and departmental conclusions based on the public consultation meetings and environmental evaluation are incorporated into the final IEE.

1.5.2 Sources of Information

To the extent possible, the IEE is based on existing information and documents such as the U.S. Army Corps of Engineers EIS, information submitted and reviewed under Saskatchewan's EIA process, including the SBDA EIS and public meeting summaries. Some information extracted from these documents is presented almost verbatim in the IEE.

In instances when information was not readily available to determine effects or mitigative possibilities, it was evident that further study was necessary. Additional data gathering took the form of reviews of recently published and unpublished material pertinent to the project, consultations with individuals to obtain technical expertise and advice, and reviews of closely related projects with similar potential for environmental effects. Where practicable, additional studies were conducted, such as modelling the effects of water quantity and quality changes at the two Souris River crossings of the international boundary.

2 PUBLIC INPUT

2.1 Introduction

Water resources in the Souris River Basin have been the subject of numerous studies, commissions and task forces since the area was first settled. The desire for better management of the basin's unpredictable and untimely water supply has always been at the heart of public discussion, and local public opinion on the best way to improve water management has historically been strong, emotional and divided. Much of that controversy has been focused on the proposals for Alameda Dam on Moose Mountain Creek and Rafferty Dam on the Souris River, proposals that date back to 1907 and 1932, respectively.

The final report of the Souris River Basin Study Board succinctly captures the past and recent flavour of public opinion on the Project in Saskatchewan:

> **"Opinions as to the acceptability ranged from absolutely essential to complete rejection. There was no consensus as to the acceptability of the project." (Souris River Basin Study Board, 1978)**

This firmly divided opinion was again reflected in letters sent by residents of the basin to the federal Minister of the Environment during the first six months of 1988. A total of 560 people wrote to the Minister, with 286 (51.07 percent) favouring the proposed Project and 274 (48.93 percent) people against it. This public opinion was clearly divided geographically. From areas upstream of the proposed dams, 99.16 percent of the people who wrote were against the Project; from downstream areas, 99.07 percent were in favour.

2.2 History of Public Involvement and Opinion

1907-1932: The Council minutes of the town of Alameda record a discussion about damming Moose Mountain Creek in 1907. In 1932, newspapers record discussions concerning damming the Souris River near the area of the proposed Rafferty Dam.

1940-1959: In 1940, the Souris River basin was the subject of an International Joint Commission Reference. In June of that year, the Commission held public meetings in Melita, Minot and other locations in North Dakota, and in Estevan. About 100 people attended these meetings as individuals or representatives of interested groups. The major issues identified were drought, water quality and upstream drainage projects. Given the recent drought of the 1930s, flood damage was not an issue with the general public. Concern was related to water supply and the desire for water management measures to control and ensure water supply.

The IJC concluded there was insufficient existing hydrologic information to complete the 1940 reference or to design water storage projects and stated that until such data were made available, no permanent method of regulating or apportioning the flow of the Souris should be adopted. However, interim measures for sharing the waters of the basin between Canada and the United States were established in 1940, and a mechanism was put in place by which interested parties could make application to the IJC for projects involving control of the flow of the Souris River.

During this period (1940-1958), the IJC established the International Souris Board of Control (1940) and the International Souris Red River Board (1948). Additional hydrometric stations were established, and a body of stream flow data was collected.

By 1958, the IJC was ready to proceed with a final report to the governments of Canada and the United States under the 1940 Reference. Again, the IJC founded its recommendation on the basis of advice from technical experts and from the people who lived in the Souris River basin. Public hearings were held, and the results of those hearings again indicated the continued and growing concern of basin residents for better water management. The IJC recommended changes to the 1940 Interim Measures; these were adopted in 1959.

1959-1978: In recognition of the public demand for better water management, the Canada-Saskatchewan and Canada-Manitoba Consultative and Advisory Committees were formed to focus on the water management requirements of the Souris River Basin. However, public concern over water management continued to grow, and the mayors of Oxbow, Estevan, Weyburn and Moose Jaw with representatives from other interest groups formed the Souris Moose Jaw Water Association which presented a Brief to the government of Saskatchewan. In response to the Brief and other publicly conveyed concerns, the governments of Canada, Saskatchewan and Manitoba formed the Souris Basin Working Group which reported to the three governments in June, 1972. They recommended a program of studies designed to address the concerns of basin residents about water management.

In 1974, the governments of Canada, Saskatchewan and Manitoba signed the four-year Souris River Basin Study Agreement. The public played an important role in this study and, through the formation of five public Task Forces, assisted the Study Board in the development of a water resource management framework. It would consider the perceptions, attitudes and ideas of the residents of the basin in assessing management alternatives. The task forces comprised rural municipality, town, village and city councillors and Souris Valley residents. The Saskatchewan Task Forces were from Weyburn, Estevan and Oxbow-Carnduff and the Manitoba Task Forces represented Melita and Souris.

In total, 80 public meetings and over 2000 hours of volunteer time were devoted to Task Forces by residents throughout the basin. The results of Task Force opinion on various management alternatives again point out the deep division of opinion between the upstream and downstream parts of the basin in Saskatchewan, especially with respect to Rafferty Dam and Reservoir. Rafferty was assessed under five different plans of design and operation. In each instance, the Weyburn Task Force assessed the project as not acceptable, the Estevan Task Force assessed the project acceptable, and the Oxbow-Carnduff Task Force had no definite opinion. Objections to the Rafferty Dam and Reservoir were first introduced in the Weyburn Task Force, and the re-emergence of a strong public movement towards constructing Rafferty developed out of the Estevan Task Force. The Oxbow-Carnduff Task Force first introduced and acted on the idea of involving residents of North Dakota in addressing cooperative water management.

1978-1982: During this period some work resulting from the Souris studies was undertaken, such as the expansion of Nickle Lake, Weyburn Channel modification and the relocation of Estevan water supply source. What many people viewed to be the principal problem of local water management - the construction of water supply and control works - was not addressed.

During this period, some citizens in both Saskatchewan and North Dakota were promoting the perceived potential benefits of a Rafferty Dam and Reservoir. This resulted in a cooperative Saskatchewan-North Dakota plan for effective, comprehensive water resource management within the Souris River basin.

1983-present: In August 1984, an informal public meeting attended by about 65 people took place in Estevan. In cooperation with Saskatchewan Power Corporation (SPC), the proposed Rafferty Dam and Reservoir were described and discussed in conjunction with the plan for the Shand Thermal Generating Station. SPC advised that these projects were being given detailed review and solicited public input.

Following the provincial announcement in February 1986 to build the Project, Saskatchewan Power Corporation and other related Saskatchewan government agencies held a series of public involvement and information meetings in Midale, Alameda, Weyburn, Carlyle and Estevan. Further to these general meetings, contact was made with special interest groups, and meetings were held with the Saskatchewan Wildlife Federation, the Saskatchewan Natural History Society, Ducks Unlimited (Canada), the Dr. Mainprize Regional Park Committee and the Lutheran Bible Camp Committee. Each group received project background information and was asked to provide comments to the newly formed Souris Basin Development Authority (SBDA), which had been created to plan and construct the two dams and related facilities.

In May, 1986 the SBDA formally assumed its duties and became the effective vehicle for subsequent public involvement. The SBDA used the foundation of public input established under the Souris River Basin Study. A "store front" office was developed to provide easy access to information, a public involvement director was hired and a general information program was developed around a Dr. Sam Souris character, who provided articles about the Project to weekly newspapers in the basin.

On May 30, 1987, the SBDA filed an Environmental Impact Statement (EIS) with the Department of Environment and Public Safety. Copies of the EIS along with Saskatchewan Environment and Public Safety technical review comments were initially made available for public review from August 17 to September 16, 1987 at 16 locations in the Souris Basin in Saskatchewan and in Regina and Saskatoon public libraries, the Legislative Building and Saskatchewan Environment and Public Safety library. The original 30-day review period was extended for an additional 30-days by the Minister of Environment and Public Safety. During this 60-day period, the public was asked to send written comments on the proposed Project to the Department of Environment and Public Safety.

While the SBDA was preparing the EIS in 1986, the Minister of Environment and Public Safety decided that an independent Board of Inquiry was warranted to review the proposed project. On July 27, 1987, the Rafferty-Alameda Board of Inquiry was appointed by Ministerial Order. The terms of reference for the Board of Inquiry called for a review of all information on the proposed project, recommendations to the Minister of Environment and Public Safety as to whether the project should proceed, not proceed, or proceed subject to specified conditions, and receipt of public comment on any matter related to the proposed development.

On August 17 and 18, 1987, information meetings were held by the SBDA at the direction of the Board in Carlyle, Alameda, Oxbow, Weyburn and Estevan. The Board of Inquiry then proceeded with a series of public meetings to receive public comment on the proposed projects. These meetings were held in Carlyle, Oxbow, Weyburn, Estevan and Regina between September 9 and 21, 1987.

The Board of Inquiry reported to the Minister of Environment and Public Safety on January 25, 1988 and recommended granting the Souris Basin Development Authority the appropriate licence to proceed with the Rafferty-Alameda Project subject to a number of recommendations dealing with mitigation and compensation.

On February 15, 1988 the Saskatchewan government granted the necessary provincial licence and approvals to build the Rafferty-Alameda Project.

On April 10, 1989, the Federal Court of Canada quashed the license granted to Saskatchewan for the Project under the International Rivers Improvement Act (IRIA) issued by Environment Canada. The Minister of the Environment was ordered to comply with the Environmental Assessment and Review Process (EARP) Guidelines Order in considering granting the licence under the IRIA.

On June 05, 1989 Environment Canada released a Draft Initial Environmental Evaluation (IEE) of the Project as the first step in complying with the EARP guidelines order. The Minister of the Environment decided to hold a series of public meetings to solicit public response to the draft IEE and public input in completing the document.

From June 22-June 29, 1989 Environment Canada held public meetings in Regina, Estevan, Oxbow, Minot, Melita, Souris and Brandon. In total, 281 written and verbal briefs were presented at the public meetings and were received by the July 10th deadline established for the submission of written briefs.

Results indicate that a majority of those Canadians presenting briefs support the Project (187 briefs for - 58 briefs against) with an additional 26 briefs in support of the Project submitted by U.S. citizens at the public meeting in Minot. Briefs presented in support of the Project generally cited issues and factors unrelated to the Draft IEE as the basis for support. Briefs opposing the Project generally addressed issues and factors raised by or contained in the Draft IEE as well as issues unrelated to the Draft IEE.

Those individuals and groups presenting briefs in favour of the Project overwhelmingly cited water management and economic benefits associated with the Project as the basis of their support and felt that the Souris Basin Development Authority had prepared an adequate mitigation plan. In the 187 Canadian briefs supporting the Project issues related to the perceived economic benefits of the Project as a result of enhanced agricultural, industrial, recreational, wildlife and municipal water use, plus job creation and overall regional economic development and diversification were raised 327 times. Issues related to water management and conservation, flood protection and good mitigation measures proposed by the SBDA were raised about 270 times. The most frequently raised issues from the Draft IEE related to waterfowl loss (9), rare and endangered species (7) and water quality improvements (11). In all cases these issues were raised in disagreement with the information contained in the Draft IEE.

In the 58 briefs submitted opposing the Project, issues related to sustainable development, the need for independent study, the need to assess alternatives to the Project, reservoir filling and impacts in Manitoba formed the basis for opposition. Issues related to sustainable development were raised 36 times, the call for independent study including the assessment of alternatives was raised 63 times; issues related to impacts in Manitoba were raised 15 times and reservoir filling and evaporation loss was raised 25 times.

With respect to the interjurisdictional aspects of the Project, 26 of the 28 briefs presented by U.S. citizens at the Minot meeting supported the Project while the Government of Manitoba and both Manitoba opposition Parties called for the Project to be subjected to the full EARP Panel review.

In summary, the briefs presented by both opponents and proponents of the Project, and issues raised in those briefs, overwhelmingly address the broad subjects of overall water management and assessment, regional economic development and diversification and sustainable development rather than the technical aspects of specific subjects of federal concern.

Transcripts of all briefs presented plus a more detailed summary is contained in the Public Input Volume of the IEE.

3 PROJECT PROPOSAL

The Rafferty-Alameda Project, as defined by the Souris Basin Development Authority, includes the:

- Rafferty Dam and Reservoir on the Souris River, 6 km northwest of Estevan;
- Rafferty-Boundary Diversion Channel;
- downstream channelization from the Rafferty Dam to near the Shand Thermal Generating Station; and
- Alameda Dam and Reservoir on Moose Mountain Creek, 4 km northwest of Oxbow.

This IEE is focused on the Project as defined above, together with the interrelationships with associated projects described in Section 4.2. This review will mention where appropriate but will not assess in any detail potential projects for which no proponent or proposals are in place, such as increased wetland drainage, interbasin water transfers or increased ground water pumping for the purposes of augmenting water supply.

3.1 General Layout

3.1.1 Rafferty Dam and Reservoir

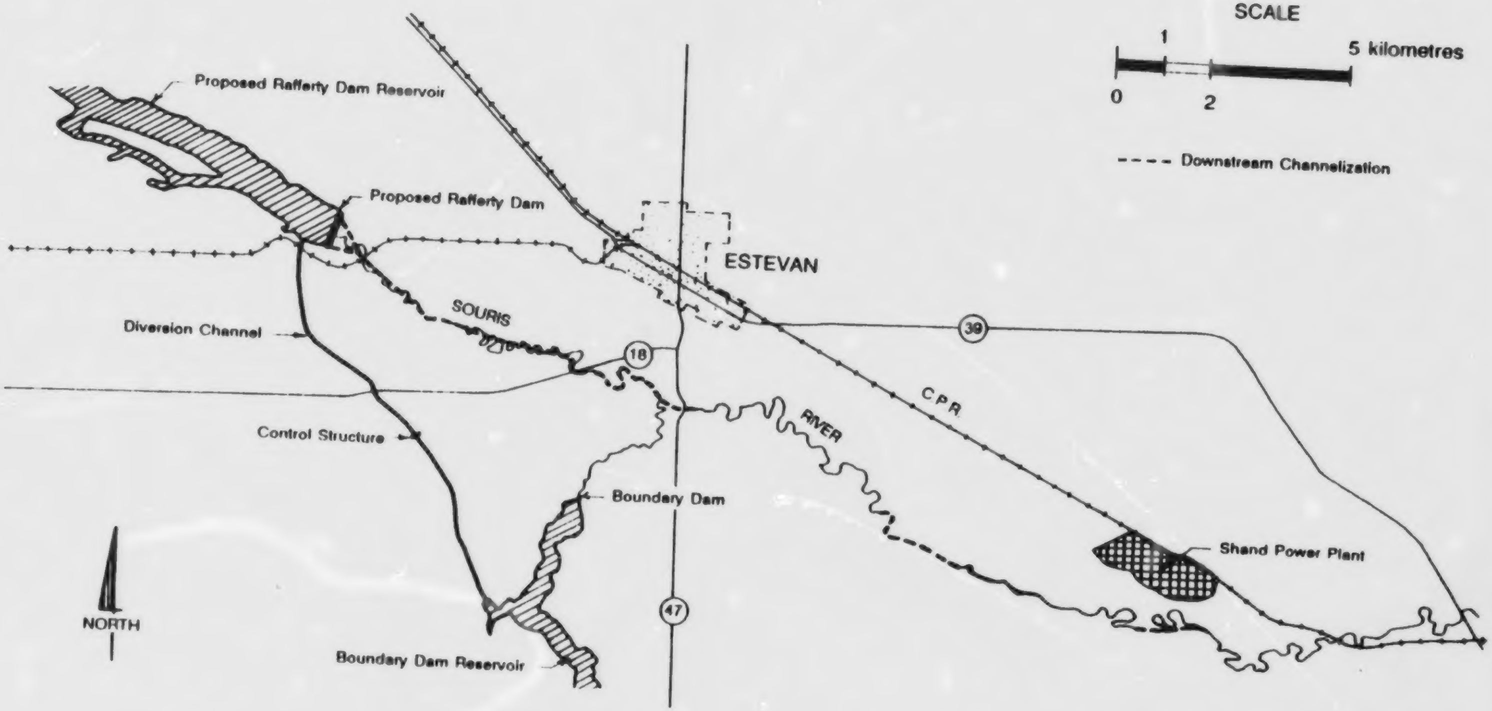
The proposed Rafferty Dam site is located on the mainstem of the Souris River 6 km northwest of Estevan (W½-25-2-9-W2)(Figure 3.1). Facilities at Rafferty Dam will include a 20 m high earth-fill dam, a concrete service spillway, a low level outlet, an emergency spillway and a reservoir.

The multi-purpose reservoir would provide flood protection and a water supply for the Shand Thermal Generating Station, irrigation, recreation, and municipal users. When filled to its full supply level (FSL) of 550.5 m, the Reservoir would be 57.0 km long and have a surface area of 4900 ha. (Table 3.1). For the first 20 to 25 years, an initial operating level of 1 m below FSL has been proposed by the SBDA to permit recovery of oil reserves in the upper portion of the reservoir.

3.1.2 Rafferty-Boundary Diversion Channel

The Proponent proposes to construct an 8.2 km long diversion channel to connect Boundary and Rafferty reservoirs, (Figure 3.1) and permit their joint operation. Concrete inlet and outlet structures, a gated control structure and a pump station will also be constructed. Pumping will be required to transfer water from Rafferty Reservoir to Boundary Reservoir because the slope is from Boundary to Rafferty. The channel will be designed for a maximum flow capacity of 60 m^3/s.

LOCATION MAP: RAFFERTY DAM, DIVERSION CHANNEL, DOWNSTREAM CHANNELIZATION AND SHAND POWER PLANT



Environment Canada
Environnement Canada
Conservation and Protection
Conservation et Protection

Rafferty - Alameda Project
Initial Environmental Evaluation

FIGURE: 3.1 Location Map, Estevan Area

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

Table 3.1 Rafferty Reservoir Characteristics

Level	Area (ha)	Length (km)	Volume (dam^3)	Max. Depth (m)
Minimum Supply (537.5 m)	1 140	18.9	10 400	2.5
Working Supply (544.5 m)	3 250	47.0	163 000	9.5
Initial Operating (549.5 m)	4 600	55.5	292 000	14.5
Full Supply (550.5 m)	4 900	57.3	440 000	15.5
Maximum Flood (554.0 m)	6 200	61.5	633 000	19.0

Joint operation of the two reservoirs would be useful in meeting downstream demands, international flow commitments on the Souris River, demand for cooling water at the Shand Thermal Generating Station and demand for projected irrigation use. Joint operation will also permit Rafferty storage to be used to maintain water levels at Boundary Reservoir and will allow the storage of flood waters transferred from Boundary to Rafferty.

3.1.3 Downstream Channelization

Channel modifications are proposed for approximately 16 km downstream of Rafferty Dam to accommodate flow releases for irrigation, recreation and flood control (Figure 3.1). Sask Power will construct a pipeline to transport water directly from the Reservoir to the Shand Thermal Generating Station.

From Highway 18 upstream to the dam, continuous channel excavation is required, and bottom dredging is proposed for the reach from Highway 18 to the CPR spur line running south to the Shand site. Downstream of the spur line to the Shand site, works would consist of meander loop cutoffs and channel dredging. Additional works downstream from the spur line would include lowering the CPR weir crest, relocating Highway 47 and dredging the bottom upstream of Highway 47. Initial capacity of the channel upstream of the spur line will be 14 m^3/s. Below the spur line, channel capacity will be 85 m^3/s.

3.1.4 Alameda Dam and Reservoir

The proposed site of the Alameda Dam is on Moose Mountain Creek 4 km northwest of Oxbow (N½-32 - 33-3-2-W2), (Figure 3.2). Like Rafferty, the Alameda Reservoir would be multipurpose in nature providing water for irrigation, recreation, flood control and downstream apportionment.

Facilities include a 40 m high earth-fill dam, a concrete service spillway, an emergency spillway and a reservoir. In February 1989, an agreement was signed between the Souris Basin Development Authority (SBDA) and Minot, North Dakota to construct a high level outlet which would improve water quality in the Souris River. This is described in more detail in Section 5, Water Quantity.

At full supply level (562.0 m) the reservoir will extend 22.75 km upstream and cover an area of 1240 hectares (Table 3.2).

Table 3.2 Alameda Reservoir Characteristics

Level	Area (ha)	Length (km)	Volume (dam³)	Max. Depth (m)
Minimum Supply (555.85 m)	624	16.5	50 700	28.9
Full Supply (562.0 m)	1240	22.8	105 500	35.0
Maximum Flood (567.0 m)	2180	26.0	189 600	40.0

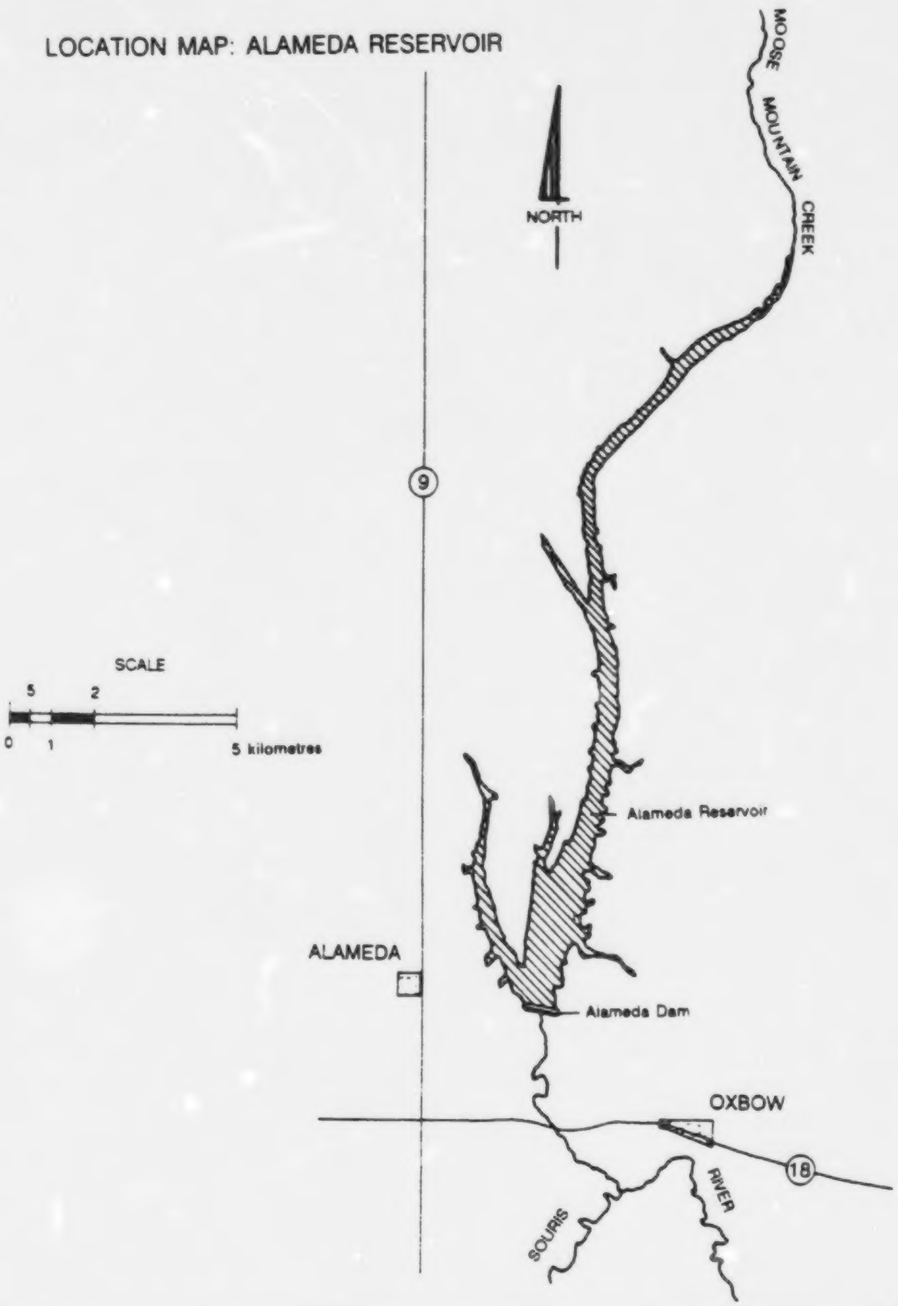
3.2 Construction Details

3.2.1 Construction Scheduling

As of January 1987, scheduling of construction was as shown in Table 3.3. All work would be seasonal, with a majority of the work to be completed by the end of the 1990 construction season.

To March 1989, the following work had been completed at the Rafferty Dam site:

- coffer dams complete with a gap provided for Souris River flow,
- wick drains installed,
- 250 000 m/³s of fill placed on the main dam,
- outlet structure of the low level outlet complete, and
- work initiated on the inlet.



LOCATION MAP: ALAMEDA RESERVOIR

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Rafferty - Alameda Project Initial Environmental Evaluation

FIGURE: 3.2 Location Map, Alameda Reservoir

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

Table 3.3 **Construction Schedule**

Works	Construction to Start	Anticipated Completion Date
Rafferty Dam	April 1988	October 1990
Diversion Channel	not available	not available
Downstream Channelization	Spring 1989	Fall 1989
Alameda	Spring 1989	Fall 1990

3.2.2 Construction Methods and Sources of Material

3.2.2.1 Rafferty Dam and Facilities

The following information was extracted from the SBDA EIS (SBDA 1987a). The impervious section of the dam is to consist of compacted glacial till derived mainly from the emergency spillway. To compensate for low strength clays in the foundation, berms would be placed both upstream and downstream. Wick drains have been placed under the dam fill to relieve foundation pressure. A rock face would protect the upstream side from wave action.

Topsoil would be stripped from most construction areas and stockpiled for later use. Due to the abundance of surface rocks, the emergency spillway area will not be stripped of topsoil.

On-site fuel storage would be kept to a minimum. If fuel storage is required, containment dykes would be constructed.

Coffer dams have been constructed around the main dam fill area and the low level outlet pipe area. A gap was left to allow passage of spring runoff.

Fill for dam construction is to be obtained from the emergency flood channel, granular material from a source approximately 3 km upstream, and riprap from nearby surface uplands as well as the granular source area.

3.2.2.2 Rafferty - Boundary Diversion Channel

The 8.2 km earth channel will vary in bottom width from 4 m to 8 m with side slopes ranging from 2H:1V to 4H:1V depending on the nature of local surficial material. The inlet structure, a concrete or rock-filled weir, will maintain sufficient depth of water in the channel to prevent erosion of the channel bottom when water is transferred from Rafferty to Boundary reservoirs. Erosion at the outlet will be minimized by construction of a concrete weir and stilling basin. Material excavated from the channel will be used as fill for a section of the road connecting Highways 18 and 39 across the dam. The channel crosses an area disturbed by strip mining.

3.2.2.3 Downstream Channelization

Considerable channel excavation, bottom dredging, and straightening are proposed to increase the capacity of the channel. Dragline excavation would be used in wet areas, whereas other portions are suitable for scraper excavation. Spoil material is to be deposited into environmentally acceptable areas and shaped aesthetically. Granular material would be obtained from borrow pits located 3 km upstream of the Rafferty Dam site.

Channelization would require construction of several new bridges and relocation or replacement of the Estevan water supply pipe, Sask Tel underground cables and Sask Power (Energy) gas pipelines. The Canadian Pacific Railway weir will be replaced by a sheet steel pile and rock-fill weir structure.

3.2.2.4 Alameda Dam

The site selected for Alameda Dam has been changed since the SBDA EIS was completed. Information on the new site is not given in the EIS. The new site location is shown in Figure 3.2 and described in section 3.1.4.

2.2.3 Reservoir Filling Plan

After construction of the dams was complete, the rate of reservoir filling would depend on annual runoff and water consumption. During construction and filling, water will be made available according to Sask Water's "General Guidelines Respecting the Administration of Water Rights in the Souris Basin in Consideration of the Rafferty and Alameda Reservoirs Project" (June 1987).

4 PROJECT SETTING

4.1 The Souris River Basin

The Souris River rises in southeastern Saskatchewan and flows southeasterly into the United States near Sherwood, North Dakota to about 50 km south of Minot. It then turns north and flows northeasterly into Manitoba to its confluence with the Assiniboine River 40 km southeast of Brandon. The total length of the river is approximately 1173 km. The Souris River basin encompasses approximately 62 120 km² with 22 010 km² (35 percent) in Saskatchewan, 16 490 km² (26 percent) in Manitoba and 23 600 km² (39 percent) in North Dakota (see Figure 4.1)

In Saskatchewan, the main tributaries to the Souris River in Saskatchewan are Long and Moose Mountain creeks. Des Lacs, Wintering, and Deep rivers are important North Dakota tributaries. In Manitoba, major tributaries are Plum Creek, Gainsborough Creek, and Antler River.

4.1.1 Physiography

The Souris River basin lies partly in the Drift Prairie section of the Central Lowland physiographic province and partly in the Missouri Coteau, which forms the eastern border of the Great Plains physiographic province. Other major physiographic features are the Missouri Escarpment, ground-moraine plain, the lake bed of glacial Lake Souris, the southeastern portion of the Turtle Mountain Prairie Uplands and the Upper Assiniboine Delta. The Souris River valley is a glacial spillway averaging less than 30 m in depth; the river channel varies from 2 to 8 metres in depth.

4.1.2 Climate

The climate in the Souris River valley is semi-arid continental, typified by extreme variations in both temperature and precipitation. Annual potential evapotranspiration (water lost through evaporation from moist soils and passing through plant tissue by transpiration) usually exceeds precipitation. As an example, the mean annual precipitation at Estevan for the period 1951 to 1980 is 433.5 mm, while the mean annual gross evaporation is 870.6 mm. The result is an average annual soil moisture deficit of 437 mm.

Precipitation at Estevan during the period 1951 to 1980 varied from a monthly mean low of 17 to 20 mm during the winter months, November to March, to a monthly mean high of 77.6 mm in June. The majority (65 percent) of the annual precipitation falls within the five month period May to September. The largest 24-hour rainfall in 44 years of record is 91.7 mm. Storms bringing this kind of rainfall occur when warm moist air moving north from the United States meets a cold front.

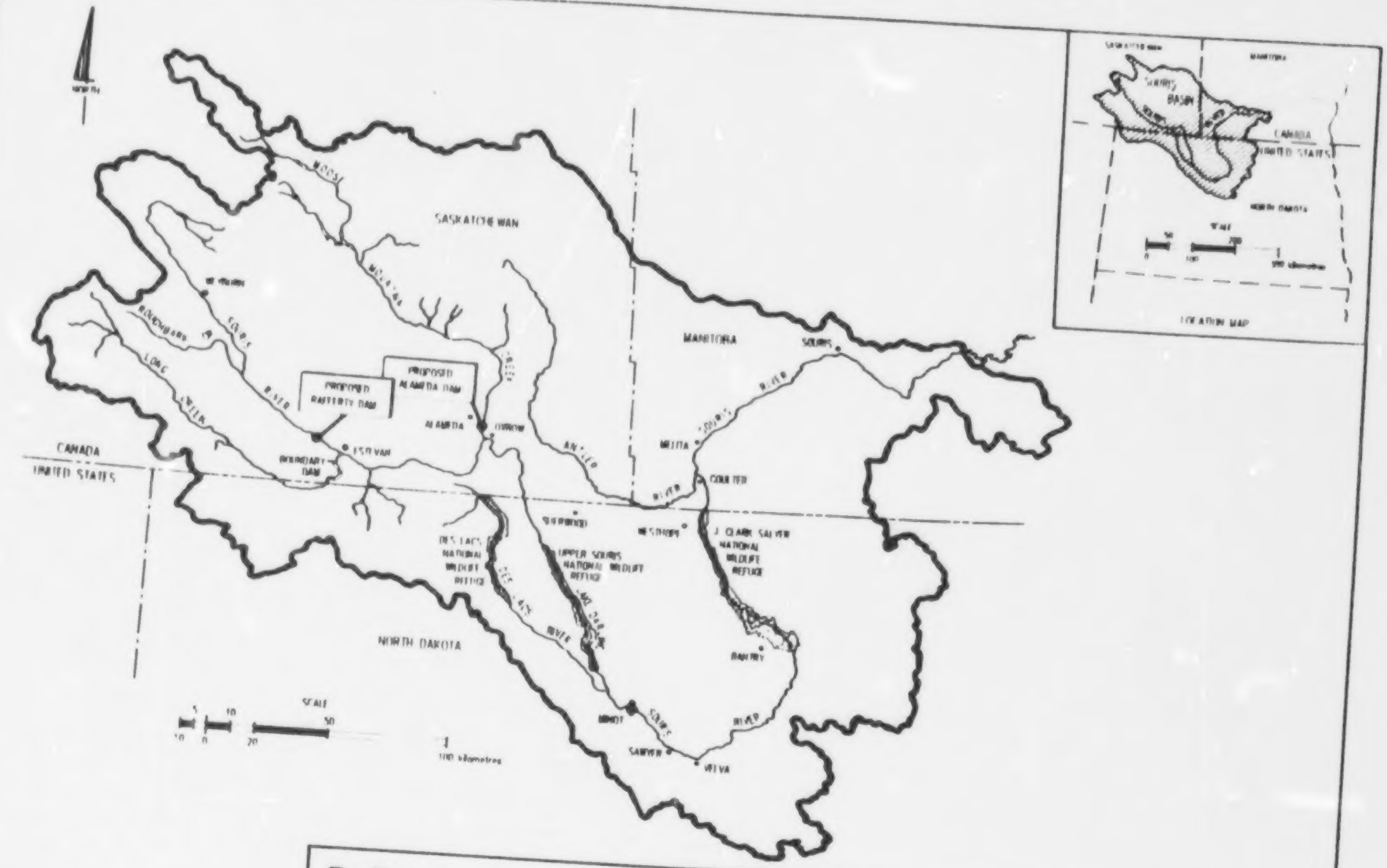

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FIGURE: 4.1 Souris River Basin Map

SOURCE: Environment Canada Conservation and Protection

Although most of the annual precipitation falls during the summer months, very little rainfall contributes to stream flow. The majority either infiltrates the soil or is lost to evaporation from sloughs and lakes or to plant evapotranspiration.

4.1.3 Vegetation

Natural vegetation is closely associated with climate. In the southwest portion of the basin, vegetation consists of mixed-grass prairie. As moisture increases to the north and east, the natural vegetation tends toward parkland and aspen forest interspersed with tall-grass prairie. Much of the original vegetation has been eradicated by man; only areas unsuitable for agriculture remain in as native vegetation.

4.1.4 Population

Demographic trends in the Souris River basin show an overall gradual decline in the rural population, combined with a steady increase in the proportion of the population in the older age groups.

In 1986, the population of the Saskatchewan portion of the basin was almost 62 000 (35 percent of the basin population), with the cities of Estevan and Weyburn having 10 768 and 10 477 residents, respectively. In 1980, the population in the Souris River basin in North Dakota was 97 000 with the city of Minot (population 33 000) being the major economic centre. In Manitoba, the total basin population (1986) was 14 600. The communities of Melita and Souris are the major urban centres, with populations of 1239 and 1751, respectively.

Although not located in the basin, Regina serves as a regional centre for the Saskatchewan portion of the basin both in terms of consumer shopping and as a major farm service centre. Brandon serves a similar role in Manitoba, as does Minot in North Dakota.

4.1.5 Recreation

The major recreational developments in southeastern Saskatchewan are Moose Mountain Provincial Park (Kenosee) and part of the White Bear Indian Reserve adjacent to Kenosee Lake. There are four main regional parks on the Souris River, Nickle Lake, Dr. Mainprize, Woodlawn and Moosomin with several smaller, less developed parks. Kenosee and White Bear are the main cottage development areas with minor development occurring at Boundary Reservoir Dam. There has been an increasing demand for recreation facilities as indicated by the recent expansions at Kenosee (new hotel and golf development) and White Bear (golf course). Such developments have occurred despite the steady decline in mean water levels in both lakes.

In North Dakota, the Upper Souris and J. Clark Salyer national wildlife refuges (NWR) provide traditional water-related activities such as fishing, boating and picnicking. Recreation facilities at the J. Clark Salyer NWR include a 30 km scenic auto trail, a 20 km canoe course, as well as photography and bird-watching activities from trails and observation towers.

Manitoba has two provincial parks in the basin, Turtle Mountain and Oak Lake. Turtle Mountain is a natural park and all uses must be within the determined natural carrying capacity. Oak Lake Provincial Park provides intensive day-use recreation facilities. There are also several smaller community-sponsored recreation sites. The Souris River in Manitoba is used for canoeing and sport fishing.

Hunting is an important recreational activity in both Canada and the United States. Hunting activities range from upland game birds and waterfowl to big game (mainly white-tailed deer). Sport fishing occurs throughout the basin and is discussed in the SBDA EIS (SBDA 1987a). Several communities maintain golf courses that use water directly from the river for irrigation.

4.1.6 Water Use

4.1.6.1 General

The natural flow regime of a river such as the Souris changes over time through changes in water supply brought about by alteration in runoff characteristics, the presence of control structures and through incremental increases in water uses. This section reviews in detail water uses in the Saskatchewan portion of the basin and the general characteristics of water uses in North Dakota and Manitoba. Water uses include consumptive uses, such as municipal, industrial and agricultural water supply, reservoir evaporation and thermal power cooling, and non-consumptive uses, such as water-based recreation, aquatic wildlife requirements (waterfowl, fish and other aquatic organisms) and aesthetic values.

4.1.6.2 Saskatchewan

In Saskatchewan, the water apportionment commitment at the Canada-U.S. boundary constitutes the most significant water demand in the Souris River basin. Under the 1959 Interim Measures, North Dakota is entitled to one half of the natural flow of the Souris River.

Surface water is the main source of water supply for Estevan, Weyburn, Radville, Midale and some of the smaller communities. Most of the smaller communities rely on ground water from small local aquifers. The currently licensed total annual diversion from the effective drainage area of the Souris River basin in Saskatchewan is 23 498 dam^3/year for various purposes. A summary of the licensed water uses in 1985 at various key locations is provided in Table 4.1.

Major municipal water demand centres within the Saskatchewan portion of the basin are the cities of Weyburn and Estevan with actual pumpage volumes in 1985 of 1770 dam^3 and 2060 dam^3, respectively. In 1985, the two cities

Table 4.1 Summary of Licensed Saskatchewan Water Uses - 1985 (dam^3) Located in the Effective Drainage Area Souris River Basin

	Location				
Purpose of Use	Souris River Above Weyburn Dam	Souris River Weyburn Dam to Rafferty Dam	Long Creek Sub-basin	Moose Mountain Creek Sub-basin	Souris River Rafferty Dam to USA Border
Domestic	75	695	287	234	174
Municipal	3207	84	2378	850	1690
Industrial	-	-	9000[a]	-	240
Irrigation[b]	345	1248	523	449	879
Other	-	4	64	1718	40
Multi-Purposes	-	1162	-	1172	-
TOTAL	3627	3193	12 252	4423	3023

[a] The estimated uses are 6500 dam^3 for forced evaporation and 2500 dam^3 for natural evaporation; the licensed allocation is actually 3562 dam^3.

[b] Represents irrigation of an estimated 1500 ha.

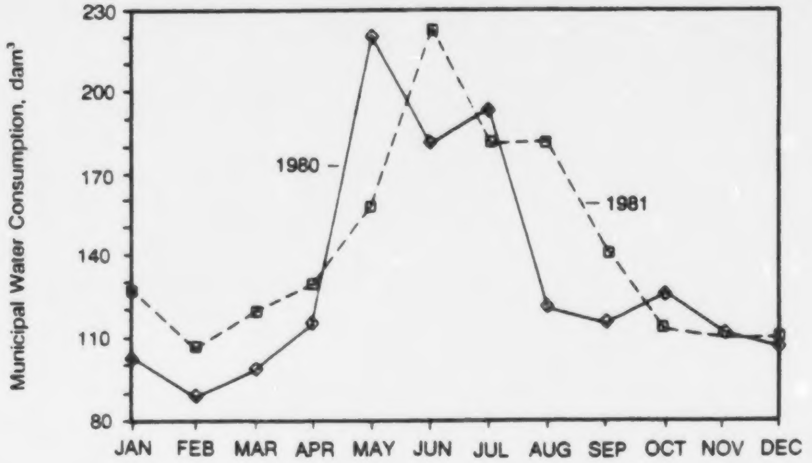
Source: Sask Water

diverted only 60 to 67 percent of their licensed annual diversions (2960 dam^3 in Weyburn, and 3096 dam^3 in Estevan). Weyburn draws its municipal water supply from Nickle Lake. Estevan no longer draws its water supply from the Souris River but, since 1985, conveys it by pipeline, from Boundary Reservoir.

Municipal water demand varies from month to month with higher demands during the summer months as shown in Figures 4.2 and 4.3. This is based on the actual records for 1980 and 1981 at Weyburn and Estevan. A steady increasing trend in total annual water demand (approximately 44 dam^3/year) is shown in Figure 4.4 for the city of Estevan.

Municipal water use is quite minor in the Moose Mountain Creek sub-basin with a total diversion of 850 dam^3/year, drawn by the town of Arcola, the regional municipality of Golden West and the villages of Creelman and Montmartre. The largest single water demand is at Moose Mountain Lake, which was constructed by Saskatchewan Agriculture for irrigation and stock watering purposes.

ANNUAL DISTRIBUTION OF MUNICIPAL WATER CONSUMPTION
ESTEVAN



ANNUAL DISTRIBUTION OF MUNICIPAL WATER CONSUMPTION
WEYBURN

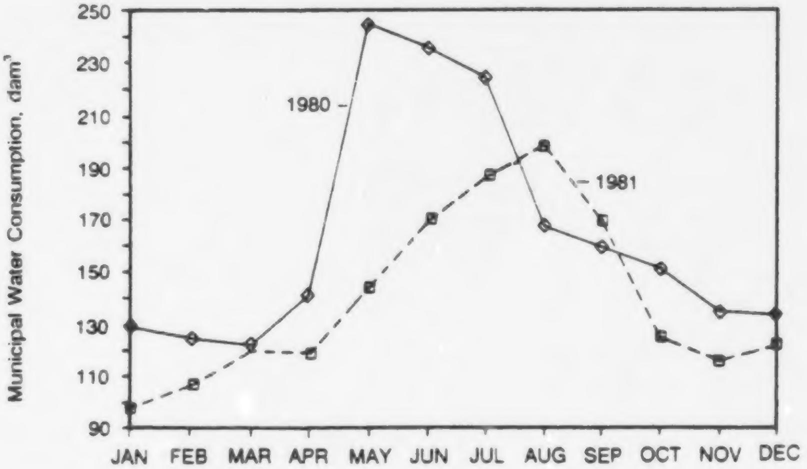


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FIGURE: 4.2 Annual Distribution of Municipal Water Consumption

DATE: July, 1989

SOURCE: Sask EIS

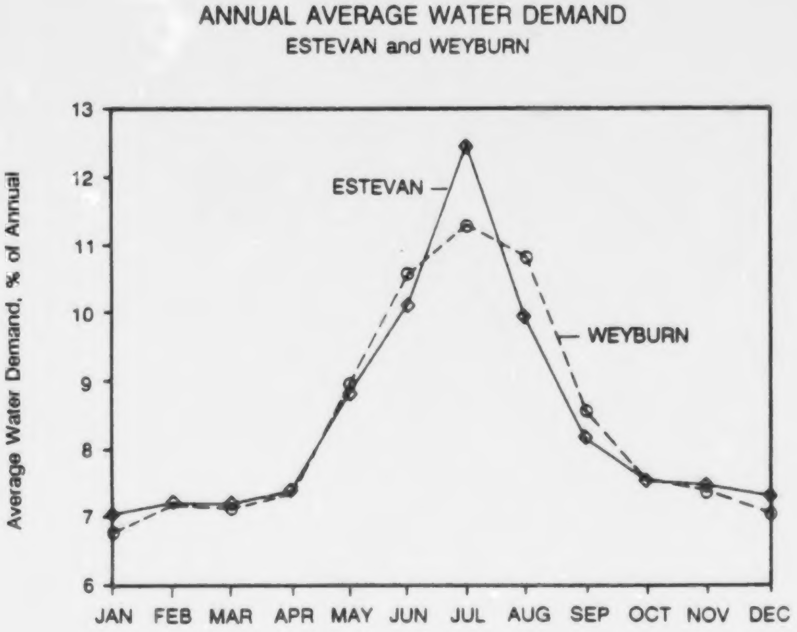

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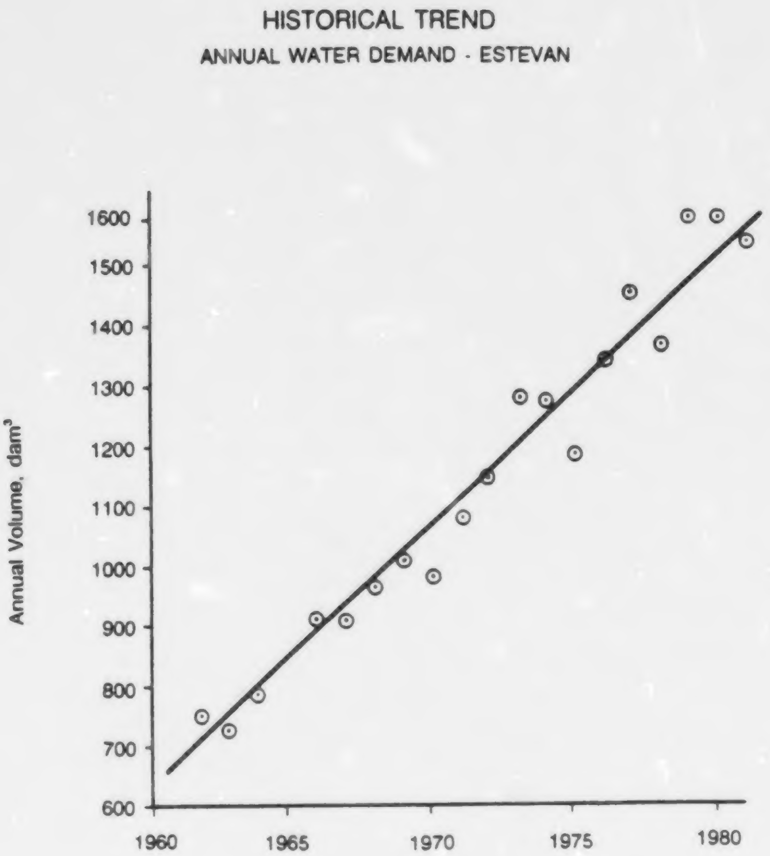
	FIGURE: 4.3 Annual Average Water Demand - Estevan and Weyburn
DATE: July, 1989	**SOURCE:** Sask EIS



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FIG[illegible].4 Historical Trends in Annual Water Demand - Estevan

DATE: July, 1989

SOURCE: Sask EIS

The major industrial demand is the Boundary Dam Power Station. The annual rate of use (1985) is 9000 dam^3; 6500 dam^3 is forced evaporation because of release of hot water back to the reservoir, and 2500 dam^3 is lost through reservoir evaporation. The licensed allocation is 3562 dam^3. Irrigation use in the Saskatchewan portion of the basin in 1985 was estimated at 3400 dam^3 for 1500 ha. Moose Mountain Lake in the upper Moose Mountain Creek sub-basin has an additional licensed use of 1770 dam^3 and represents another major use. The usage is not constant because of annual variation in storage and irregular releases. The water is used for irrigation and stock watering purposes.

In order to meet the demands of water users, a number of water supply works have been developed on the Souris River mainstream and on the tributaries. The major Saskatchewan projects are listed in Table 4.2 and shown on the map in Figure 4.5. There are also a number of natural lakes, which provide benefits such as recreation and waterfowl staging and nesting areas, but none contributes significantly to basin water supplies.

Numerous smaller blockages to flow are located on the Souris River, ranging from low level earth or rock weirs to concrete structures several metres high. The largest is the Estevan Power House Dam located downstream of the Long Creek confluence. Others weirs include one at Woodlawn Park, several culverted low level crossings, and weirs for spring backflood irrigation of valley bottom haylands.

4.1.6.3 North Dakota

In North Dakota, a water right is based on a priority in time, so that the user with the earliest dated right has priority over rights established at a later date. The major licensed uses in North Dakota are:

	dam^3
Senior Water Rights	
Miscellaneous Users	1405
Eaton Irrigation District	12 335
National Wildlife Refuges	75 242
Junior Water Rights	
City of Minot	18 194
Miscellaneous Users	4294
Total	111 470 dam^3

The city of Minot uses its allotment as much as possible for domestic purposes. The town of Westhope also uses water directly from the Souris River. An inventory of water control structures in North Dakota is given in Table 4.3 and location in Figure 4.6.

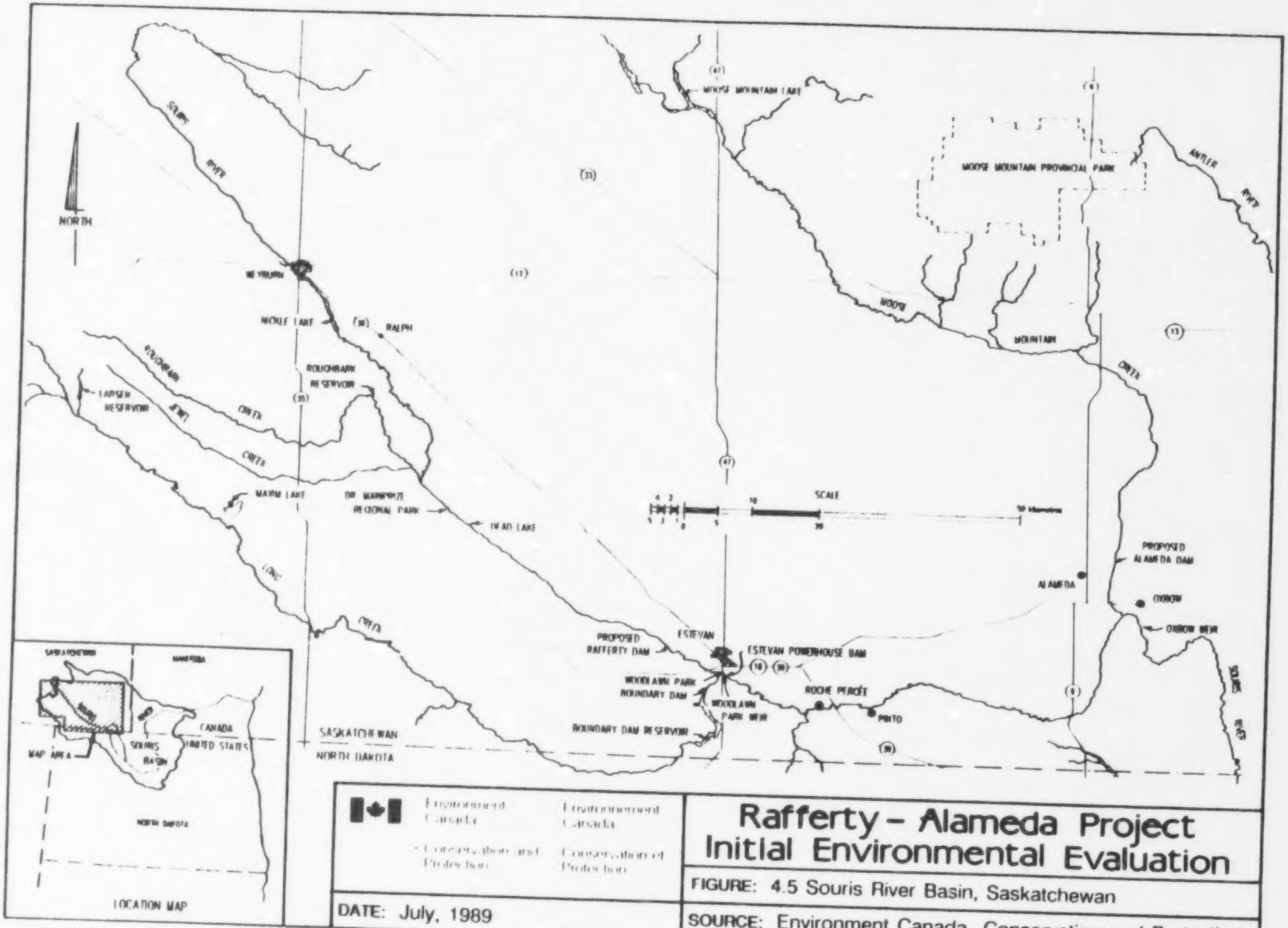

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FIGURE: 4.5 Souris River Basin, Saskatchewan

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

Table 4.2 **Major Water Development Projects Existing in Saskatchewan**

Project	Year Constructed	Water Source	Storage Capacity (dam^3)	Principal Purpose
Nickle Lake	1940	Souris River	16 000[a]	Municipal Water Supply
Roughbark Reservoir	1937	Roughbark Creek	2100	Stockwatering and Irrigation
Dead Lake	1937	Souris River	6900	Stockwatering and Irrigation
Maxim Lake	1949	Long Creek	6700	Stockwatering
Larsen Reservoir	1957	Long Creek	800	Municipal Water Supply
Boundary Reservoir	1958	Long Creek	60 600	Cooling Water for Electric Generation and Municipal Water Supply
Moose Mountain Lake	1937	Moose Mountain Creek	11 600	Stockwatering and Irrigation
Oxbow Dam	1960	Souris River	400	Recreation and Irrigation
Pipestone Dam	1938	Pipestone Creek	1 100	Stockwatering and Irrigation
Moosomin Dam	1954	Pipestone Creek	1 100	Municipal Water Supply

[a] Enlarged in 1983 from 6300 dam^3

Table 4.3 Water Management Structures in the Souris River Basin in North Dakota

Structure	Distance Above Mouth (km)	Reservoir Capacity[a] (dam^3)	Purpose	Year Placed in Operation
Souris River				
Upper Souris NWR			Migratory Waterfowl Refuge	1936-39
Dam No. 41	758	5 000		
Lake Darling Dam	692	149 000[b]	Also Water Supply	
Dam A	690	100		
Dam B	688	400		
Dam C	687	400		
Dam No. 87	685	1 600		
Dam No. 96	671	3 600		
Eaton Dam	432	2 100	Irrigation	1937
J. Clark Salyer NWR			Migratory Waterfowl Refuge	1936-39
Dam No. 1	330	1 200		
Dam No. 320	312	12 300		
Dam No. 326	299	6 800		
Dam No. 332	290	6 700		
Dam No. 341	276	6 300		
Dam No. 357	250	26 700		
Des Lacs River				
Des Lacs NWR			Migratory Waterfowl Refuge	1936-39
Upper Des Lacs Lake Dam		47 000		
Dam Nos. 2 through 8		11 000		

[a] capacity to nearest 100 dam^3

[b] Dam No. 41 is inundated by Lake Darling at full pool.

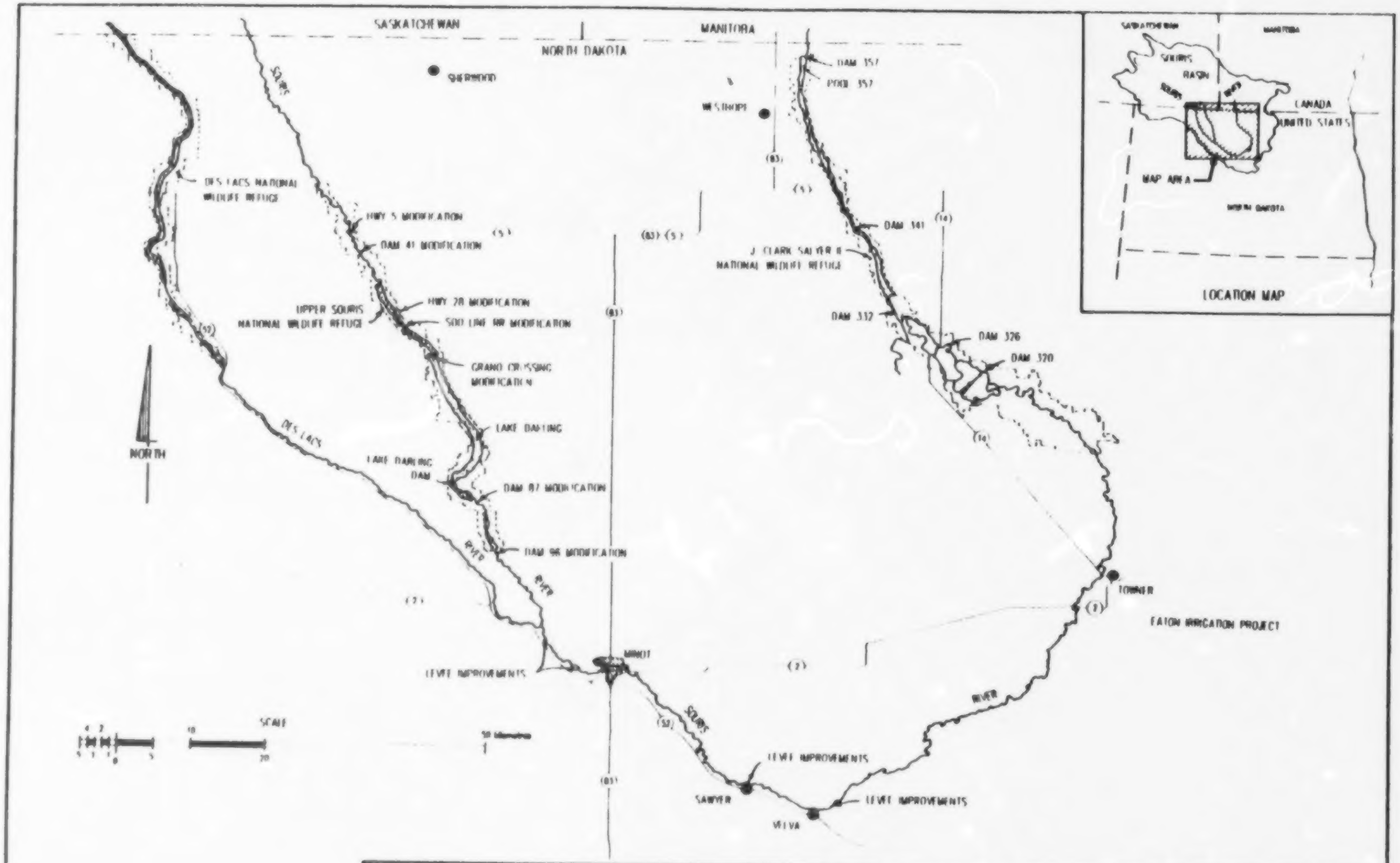

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FIGURE: 4.6 Souris River Basin, North Dakota

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

4.1.6.4 Manitoba

The town of Souris is the only major community in Manitoba that uses water from the main stem of the Souris River for municipal supply (approximately 270 dam^3 per year). Deloraine is the only other community to use surface water supplies and draws its water from Turtlehead Creek. The total estimated irrigation consumption is 800 dam^3 for 300 ha. It is estimated that 80 percent of the residents in the Manitoba portion of the basin rely on ground water for domestic use. Non-consumptive demands include aquatic wildlife, water-based recreation and the aesthetic values of riverine settings. There are also significant unlicenced water usage in Manitoba, as well as channel and evaporation losses in Manitoba during dry years. For example, during 1988 when 17,000 dam^3 was passed to Manitoba, there was zero flow at Wawanesa for 47 days during the summer months.

An inventory of water control structures on the Souris River in Manitoba is given in Table 4.4 and shown in Figure 4.7.

4.1.7 Flooding

Flooding along the Souris River has been a recurring problem. During five of the eleven years from 1969 to 1979, major crop and property damages were sustained. According to early reports, large floods also occurred in 1882 and 1904. The peak flow estimated at Wawanesa for 1882 and 1904 was 1130 m^3/s and for 566 m^3/s, respectively.

Flood hazard areas in Saskatchewan have been designated under the Canada-Saskatchewan Flood Damage Reduction Program at Estevan, Oxbow, Roche Percée and Radville. In Weyburn, flood mitigation projects consisting of dykes and channel improvements will be completed in 1990. The projects, valued at approximately $2.7 million, are being cost-shared by the city of Weyburn and the province of Saskatchewan.

Minot, North Dakota is subject to extensive flooding when flows are greater than 142 m^3/s. Minot is enrolled in the Federal Flood Insurance Program. Membership qualifies residents to purchase flood insurance, providing that municipal floodplain building regulations are in place to reduce damages to new developments. All new developments are subject to insurance premiums based on susceptibility to flooding. Executive Order 11988 prohibits the expenditure of federal money on floodplain development that is not adequately flood-proofed. Rural flooding is a problem from the boundary to Lake Darling, with some agricultural land subject to flooding downstream of Lake Darling to Minot.

In Manitoba, flood hazard areas at Melita, Souris, and Wawanesa have been designated under the Canada-Manitoba Flood Damage Reduction program. A dyke to protect the town of Souris water supply is now being constructed under the program.

Rural flooding is also a problem in the Saskatchewan portion of the basin. However, the only area that remains flooded for an extended period is near Hitchcock between McDonald Lake and the Highway 47 bridge near Estevan. The channel capacity in this reach is less than 2 m^3/s. In Manitoba, the reach downstream of the boundary, has a capacity of 4 m^3/s and is subject to flooding in most years. Agricultural damages in Manitoba occur primarily to the cultivated land in the Melita and Lauder reaches.

4.1.8 Energy Resources

In Saskatchewan, numerous oil service and drilling companies operate in the southeast portion of the province. A major water use in the oil industry is in the enhanced oil recovery process where water is injected into an oil reservoir to force the oil out. The main source of this water is from the oil reservoir itself or from other ground water sources. Coal is another major resource, providing fuel for the Boundary Dam Power Station. A portion of the coal production is also exported to Ontario Hydro and Manitoba Hydro.

There are no active commercial coal developments in North Dakota. Some scattered oil developments occur.

The Virden oilfields in Manitoba extend into a small portion of the Souris River basin north of Pipestone Creek. Lignite coal deposits in the Turtle Mountain formation were mined in the early 1900s, primarily for local purposes. Most of the remaining deposits cannot be recovered economically at present.

There are no hydro-electric facilities in the basin.

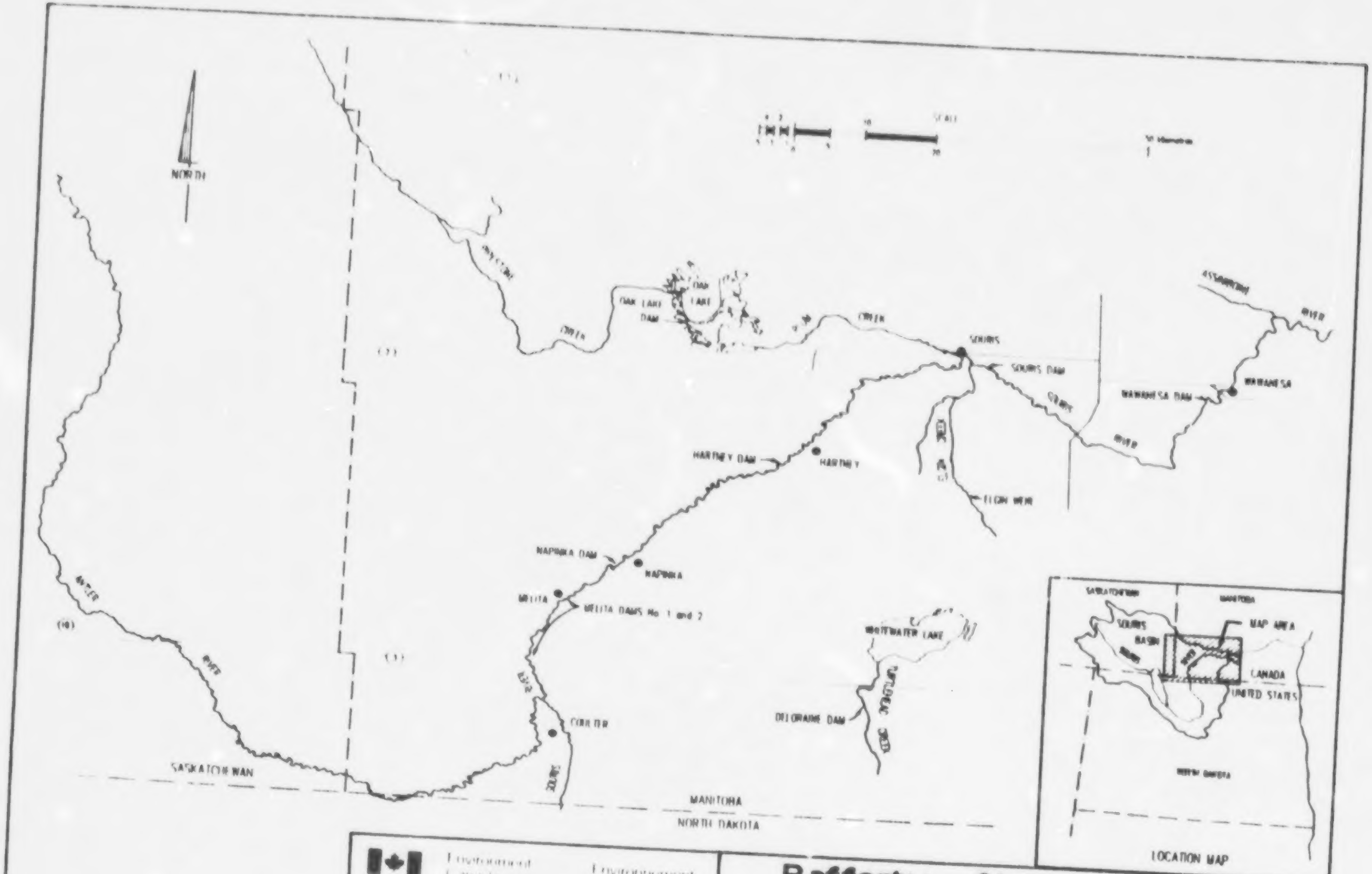
4.1.9 Landuse

The major landuse activity in the basin is agriculture, primarily grain and mixed farming. Existing irrigation is small in scale, but there is potential for some development with an assured water supply.

In the Saskatchewan and Manitoba portions of the basin, approximately 67 percent of the land is used for annual grain crops. The main crop is wheat, but barley, flax, canola, and oats are also grown. Eight percent of the land is improved hay and pasture. The remaining 25 percent represents unimproved land consisting of native pasture, wetlands and woodland.

Agriculture is also the main landuse activity in North Dakota. Major crops are small grains and sunflower. The three NWRs constitute a significant land use.

Agricultural development has left little native prairie grassland except in the NWRs. Inside the refuge boundaries, grassland is maintained for wildlife, with some farming and cattle grazing permitted when compatible with refuge management.



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Initial Environmental Evaluation

FIGURE: 4.7 Souris River Basin, Manitoba

SOURCE: Environment Canada Conservation and Protection

Table 4.4 Water Management Structures in the Souris River Basin in Manitoba

Structure	Distance Above Mouth (km)	Reservoir Capacity[a] (dam^3)	Purpose	Year Placed in Operation
Souris River				
Melita Dam No. 1	221	1000	Water Supply	1937
Melita Dam No. 2	200	600	Water Supply	1937
Napinka Dam	182	1200	Water Supply	1938
Hartney Dam	148	300	Water Supply	1941
Souris Dam	105	500	Municipal Water Supply	1952
Wawanesa Dam	20	400	Water Supply	1951
Turtlehead Creek				
Deloraine Dam	-	1700	Municipal Water Supply	1962
Pipestone Creek				
Oak Lake Dam	-	N/A[b]	Recreation	1956
Elgin Creek				
Elgin	-	600	Water Supply	1965

[a] Capacity to nearest 100 dam^3

[b] Not applicable. Dam effectively blocks drainage out of Oak Lake.

4.2 Associated Projects

4.2.1 General

Associated projects are described here in order to provide an appreciation of the overall setting and interrelationships between the Rafferty-Alameda Project and other contiguous projects. An assessment of these projects is not part of the overall federal environmental review. They form part of the Proposal in that the demand for water from Rafferty and Alameda reservoirs comes from these associated projects. As part of the Project, the Proponent has put forward firm proposals for each of the associated projects discussed here: Shand Thermal Generating Station cooling, Boundary Reservoir operation, irrigation development, and recreation/tourism facilities.

4.2.2 Shand Thermal Generating Station

The Saskatchewan Power Corporation (1986) has identified generating capacity requirements in excess of 800 MW to meet projected demand in the province by 1991. In order to meet this projected demand, the Corporation is constructing the Shand Thermal Generating Station at Shand, Saskatchewan, approximately 10 km southeast of Estevan.

The plant will consist of two 300 MW net-cooled steam turbines. The total annual water demand for the generating station will be approximately 6400 dam^3 at 80 percent capacity (SBDA 1987a). This water will come from the proposed Rafferty Reservoir, the Estevan sewage lagoons, and from coal mine dewatering.

Water would be conveyed from the Rafferty Reservoir by a pipeline along the floor of the Souris River valley via the Estevan sewage lagoons to the power plant site. The SBDA estimates the sewage lagoons will supply 1500 dam^3 and the coal mine dewatering will provide approximately 260 dam^3 of cooling water annually. By deduction, Rafferty Reservoir would be counted on to supply 4640 dam^3 annually for cooling purposes.

The cooling water system designed for the generating plant is essentially a "zero discharge" system. The Corporation has indicated that water cooling towers will be utilized in the plant cooling system to eliminate the need for discharge into the Souris River. The plant site will be contoured to ensure that external drainage will be diverted and internal drainage will be collected and treated as required.

4.2.3 Boundary Dam

Construction of the Boundary Dam Power Station began in October 1956 and was completed in 1959. Water from Long Creek is impounded behind the dam and is utilized as cooling water for the power station. The dam is 23 m high and 305 m long, creating a reservoir with a maximum flood level storage of 61 500 dam^3 at an elevation of 560.8 m. The minimum supply level of the reservoir is 24 900 dam^3, at elevation 553.2 m. The power plant has undergone three expansions since construction and, at the present time, produces 833 MW.

Although the reservoir was developed to supply cooling water for the power station, it also serves a recreation function for the local area. Approximately 50 cottages and permanent residences have been developed on leased land along the eastern and southern shores of the reservoir. A recreation site is operated by Saskatchewan Parks Recreation and Culture on the east side. It has facilities for swimming, boating and picnicking with docks, picnic tables, and barbecues located at the site.

The SBDA has proposed construction of a diversion channel from Boundary to Rafferty reservoirs, the details of which are described in Section 3.1.2.

4.2.4 Irrigation Development

The SBDA has estimated that maximum irrigation development associated with the Project will be about 4800 ha. Irrigation development would occur in two areas; approximately 3200 ha of lowland irrigation in the Souris River valley between Rafferty Reservoir and the international boundary and approximately 1600 ha of upland irrigation adjacent to Alameda Reservoir. Benefit/cost ratios for the irrigation development scenarios range from 0.62 to 2.6 depending on the economic scenario considered and the projected irrigation mix of grain, livestock, and specialty crops chosen.

Irrigated crops may include a variety of cereal grains, forage, vegetables and specialty crops. The crops ultimately chosen for cultivation will depend in large part upon market demands and prices. The Saskatchewan Water Corporation will be responsible for issuing approvals to construct and operate irrigation works. A detailed soil assessment will be undertaken for each parcel of land when a farmer submits an irrigation application and before any approval to develop is issued.

In order to determine how much land could be put into irrigation development, the Project Proponent had to determine the quantity of water that could be made available for irrigation use. The water supply studies considered supply alternatives from a combination of sources: Rafferty Reservoir, Alameda Reservoir, the diversion channel between Rafferty and Boundary reservoirs and ground water from aquifers.

Water balance models were used in the irrigation studies to examine six scenarios which provided estimates of the maximum, minimum and average amounts of water that could be available for irrigation development. Firm annual drafts (100 percent), and water yields that could be made available for irrigation 70 percent of the time were analyzed. The scenario of water being available 70 percent of the time indicated that 32 970 dam^3 of water could be available with 18 610 dam^3 from Rafferty and 16 290 dam^3 from Alameda (SBDA 1987a).

The Project Proponent proposes that for lowland irrigation, approximately 2000 ha would be supplied from releases out of Rafferty Reservoir and 1200 ha out of Alameda Reservoir (Table 4.5). In order to meet maximum projected irrigation demands, Rafferty Reservoir would need to supply 6000 dam^3 and Alameda Reservoir 3 600 dam^3 annually.

4.2.5 Recreation/Tourism Facilities

Rafferty and Alameda reservoirs are intended to provide an opportunity to satisfy a water-related recreation need for southeastern Saskatchewan. Three recreation areas associated with the project would be developed. Lower Rafferty Park would occupy the eastern end of Rafferty reservoir, Dr. Mainprize Regional Park would be inundated by the filling of the reservoir and would have to be relocated to a new site. A new park has also been proposed for the southeast side of the Alameda reservoir.

A new site for the Dr. Mainprize Park has not been chosen, although a site has been tentatively identified approximately five km northwest of the present location. The Lutheran Bible Camp located south of Halbrite, would also be relocated. No decision has been reached on a preferred site for this camp.

Development of the main park site at Rafferty would necessitate the relocation of approximately 2.5 km of railway track which crosses the Souris Valley approximately 1 km downstream from the dam. A perimeter park access road has been proposed to follow the south boundary of the park for approximately 11 km. Secondary roads will branch off from this road to provide access to various areas of the park.

The Proponent also forecasts development of cottages at the various sites. The Proponent proposes development of 125 cottage lots in the Lower Rafferty Park area along with 50 lots adjacent to the relocated Dr. Mainprize Regional Park. One hundred cottage lots are also planned for the Alameda reservoir. Cottagers would be able to purchase the developed lots or they can be leased. All cottage developments would be undertaken by private developers.

Table 4.5 Proposed Level of Irrigation Development in Saskatchewan

	Upland	Lowland
Total Development Area	1600 ha	3200 ha
Water Supply Source	Alameda 1600 ha	Alameda 1200 ha Rafferty 2000 ha
Water Demand	Alameda 7200 dam^3	Alameda 3600 dam^3 Rafferty 6000 dam^3

Source: SBDA 1987a
Chapter 13 - Irrigation

The rates of public visitation have been estimated by the Proponent and are given in Table 4.6.

In the SBDA EIS (SBDA 1987a), the province indicates that development of recreation facilities associated with the reservoirs would necessitate the formulation of park master plans and landuse controls. These plans would need to be integrated with water management plans for the project area. The Proponent's responsibility for recreation would end with completion of the Project; this would necessitate establishing an alternative organization to assume the continuing recreation management responsibilities. The form and function of this organization would have to be determined using input from the affected rural municipalities and from special interest groups. Landuse conflicts would need to be resolved through an integrated planning process that involved all interested parties. Local governments would have to be consulted on decisions regarding land and water use restrictions, zoning and building controls.

Table 4.6 Visitation to Existing and Proposed Recreation Areas

Site	Visitation Rate (visitor-days)
Existing:	Actual (1986):
Duck Mountain	274 000
Moose Mountain	603 100
Cypress Hills	212 400
Boundary Dam	42 400
Roche Percée	39 600
Woodlawn	127 900
Proposed:	Estimated:
Lower Rafferty	110 000 - 130 000
Dr. Mainprize	70 000 - 90 000
Alameda	60 000 - 80 000
Project Sub-total	240 000 - 300 000

Source: SBDA 1987a

4.2.6 Souris River Basin Project (North Dakota)

To reduce flood control problems in North Dakota, particularly for the city of Minot, the United States has decided to proceed with a project that combines the purchase of 466 000 dam^3 of flood storage in Saskatchewan with modification to, and construction of, flood control works in North Dakota. The United States would purchase flood storage in Canada for a maximum of $41.1 million (1985 U.S. dollars).

In Saskatchewan, construction of Alameda Dam and Reservoir, Rafferty Dam and Reservoir and the diversion channel linking Rafferty and Boundary reservoirs would be undertaken. The following features would be developed in North Dakota to operate in conjunction with the Canadian project features:

- modification of the existing gated outlet on Lake Darling Dam,
- improvements on control structures in the Upper Souris NWR,
- improvements to the control structures at the J. Clark Salyer NWR, including upgrading and raising three dams and adding a low flow structure on another dam, and
- the construction of urban levees at selected sites along the Souris River channel in North Dakota.

4.3 Alternatives

The Souris River Basin Study Board (1978) investigated a number of possible solutions to the various water problems identified in the Souris River basin. Each possible solution was evaluated with the most viable solutions receiving a detailed evaluation. The suggested solutions were categorized into four study sectors: flood damage reduction, water supply, water quality and water-related resources. The following narrative summarizes the Study's comments on the usefulness of Rafferty Reservoir as a solution to two of the identified problems, flood damage reduction and water supply.

4.3.1 Flood Damage Reduction

Flood damage reduction can be achieved by either structural or non-structural means or a combination of the two. The Souris River Basin Study Board (1978) examined 44 flood damage reduction possibilities for Saskatchewan, and 15 were evaluated in detail. The Study found that the existing Boundary Reservoir could only minimally reduce flood damages operating independently. The Alameda Dam and Reservoir could be utilized for flood storage if the reservoir level was lowered prior to spring runoff. The Study also found that a proposed Rafferty Reservoir (at FSL 546.7 m with 247 000 dam^3 storage) along with operational alternatives for the Boundary Reservoir, used either independently or in combination with a diversion channel between Boundary and Rafferty, would be useful in storing flood waters. The Study concluded that the preferred alternative was flood control measures involving zoning and land use regulations in combination with structural measures at selected sites.

4.3.2 Water Supply

The Souris River Basin Study considered a total of 30 water supply alternatives for Saskatchewan. Eleven of these were subjected to detailed investigation to determine their ability to meet demands during dry years. These alternatives included four different Rafferty Dam and Reservoir capacity possibilities, three various capacity pipeline diversions from Rafferty to Boundary, and the Alameda Dam and Reservoir.

Three potential storage reservoir locations on the Souris River below Roughbark Creek were evaluated, with Rafferty identified as the preferred location for a large storage reservoir. Construction of a reservoir at Rafferty was considered viable in meeting water demands because it could meet those demands for the long term without having to be supplemented by water imported into the basin. This site was upstream from the Rafferty Dam site described in the Project documents.

The Basin Study concluded that an alternative solution consisting of construction of an extension to the Weyburn Reservoir in combination with development of the Estevan Valley Aquifer was the best solution for meeting water supply demands. Rafferty Reservoir could not be justified on economic grounds without a major industrial demand for water (such as the Shand

Thermal Generating Station) which did not exist in the basin at that time.

4.3.3 Operating Plan Alternatives

Further to the Souris River Basin Study, Saskatchewan Power Corporation commissioned a reservoir multi-use feasibility study for Rafferty Dam (Fennell, Cochrane Lavalin 1983). The purpose of that study was to establish how much Rafferty water could be available for use after meeting all present and future foreseen water demands in the basin. Achieving the most beneficial use of the water available would require the coordinated operation of Rafferty and Boundary reservoirs.

The Fennell, Cochrane, Lavalin study used a multi-reservoir model to arrive at the most appropriate operating scenario for the basin as a whole. Following this, the data from this model run were used as input data for a single reservoir model which examined a variety of specific operating scenarios for Rafferty. The results of these simulations were then used to determine which combinations of uses appeared to be the most appropriate for a proposed Rafferty Reservoir. These uses provide the basis of the proposed operating plan for the Project.

5 INTERNATIONAL WATERS - HYDROLOGY

5.1 Introduction

The hydrologic analysis of the Project is largely based on the results of the work contained in the following reports:

- Souris Basin Development Authority EIS (1987a)
- U.S. Army Corps of Engineers EIS (1988)
- Manitoba Water Resources Branch, Rafferty/Alameda Dams Project - Implications for Manitoba (1988)
- Government of Manitoba Technical Response to Rafferty-Alameda Project Draft Initial Environmental Evaluation (July 7, 1989)

The hydrologic data and work contained in the above reports has been evaluated and found to be based on acceptable hydrometeorologic data, computer models and techniques. In order to assess the water quantity impacts of the Project in this IEE, several computer simulations were made by Sask Water and resulting stream flows and reservoir level data were provided. Additional analyses were carried out to verify and augment the information available in the reports. The additional work covered low flow, evaporation, reservoir filling, and reservoir salinity accumulation.

The computer models of the Souris River in Saskatchewan and North Dakota were found to provide accurate hydrologic representations of the basin. The scenarios analyzed with the models provided an envelope within which the impacts of the proposed combinations of apportionment and irrigation could be examined.

The existing hydrological and natural flow regimes of the Souris River constitute the base for understanding the hydrologic regime. A simulated historic flow regime for the Souris River was prepared for this report by Sask Water after a meeting of United States and Canadian representatives. This was simulated by a computer model regime called J55A which was an update of earlier models to include the following: the latest evaporation data; updated elevation-area-capacity values for J. Clark Salyer; an additional 1 620 dam^3 (2 000 acre-feet) of senior water rights in North Dakota; revised patterns of operation for Lake Darling, and pools 326, 332, 341, 357 and 320; and modification of the model so that local inflow between the Wintering River and the Westhope gauge entered upstream of pool 357. Project impacts on floods, low flows, monthly flows, annual volumes and water levels were identified for key locations within the Souris River basin.

The existing hydrologic regime is no longer in a natural state because of past drainage of wetlands and construction of reservoirs on the Souris River and its tributaries. The 1909 Boundary Waters Treaty and the 1959 Interim Measures led to the monitoring of the flows of Souris River for apportionment purposes. Since 1959, flow deliveries at both the international boundary crossings (Saskatchewan-North Dakota and North Dakota-Manitoba) have been administered by the International Souris River Board of

Control according to the "1959 Interim Measures" established by the International Joint Commission. The annual volume of water that Saskatchewan must pass to North Dakota on the Souris River, referred to as an apportionment, is the largest single water demand in the basin since the establishment of the apportionment measures in 1959.

According to the 1959 Interim Measures:

> "1. The Province of Saskatchewan shall have the right to divert, store, and use waters which originate in the Saskatchewan portion of the Souris River basin, provided that such diversion, storage and use shall not diminish the annual flow of the river at the Sherwood Crossing more than fifty percent of that which would have occurred in a state of nature. For the benefit of riparian users of water between the Sherwood Crossing and the upstream end of Lake Darling, the Province of Saskatchewan shall so far as practicable regulate its diversions, storage, and uses in such manner that the flow in the Souris River channel at the Sherwood Crossing shall not be less than four (4) cubic feet per second when that much flow would have occurred under the conditions of water use development prevailing in the Saskatchewan portion of the Souris River basin prior to construction of the Long Creek dam referred to in paragraphs 12 and 14 above.
>
> 2. Except as otherwise provided herein with respect to delivery of water to the Province of Manitoba, the State of North Dakota shall have the right to divert, store, and use the waters which originate in the North Dakota portion of the Souris River basin together with the waters delivered to the State of North Dakota at the Sherwood Crossing under Recommendation (1) above: provided that any diversion use or storage of Long Creek water shall not diminish the annual flow at the eastern crossing of Long Creek into Saskatchewan below the annual flow of said Creek at the western crossing into North Dakota.
>
> 3. (a) In addition to the waters of the Souris River basin which originate in the Province of Manitoba, that Province shall have the right, except during periods of severe drought, to receive for its own use and the State of North Dakota shall deliver from any available source during the months of June, July, August, September, and October of each year, six thousand and sixty-nine (6,069) acre-feet of water at the Westhope Crossing regulated so far as practicable at the rate of twenty (20) cubic feet per second except as set forth

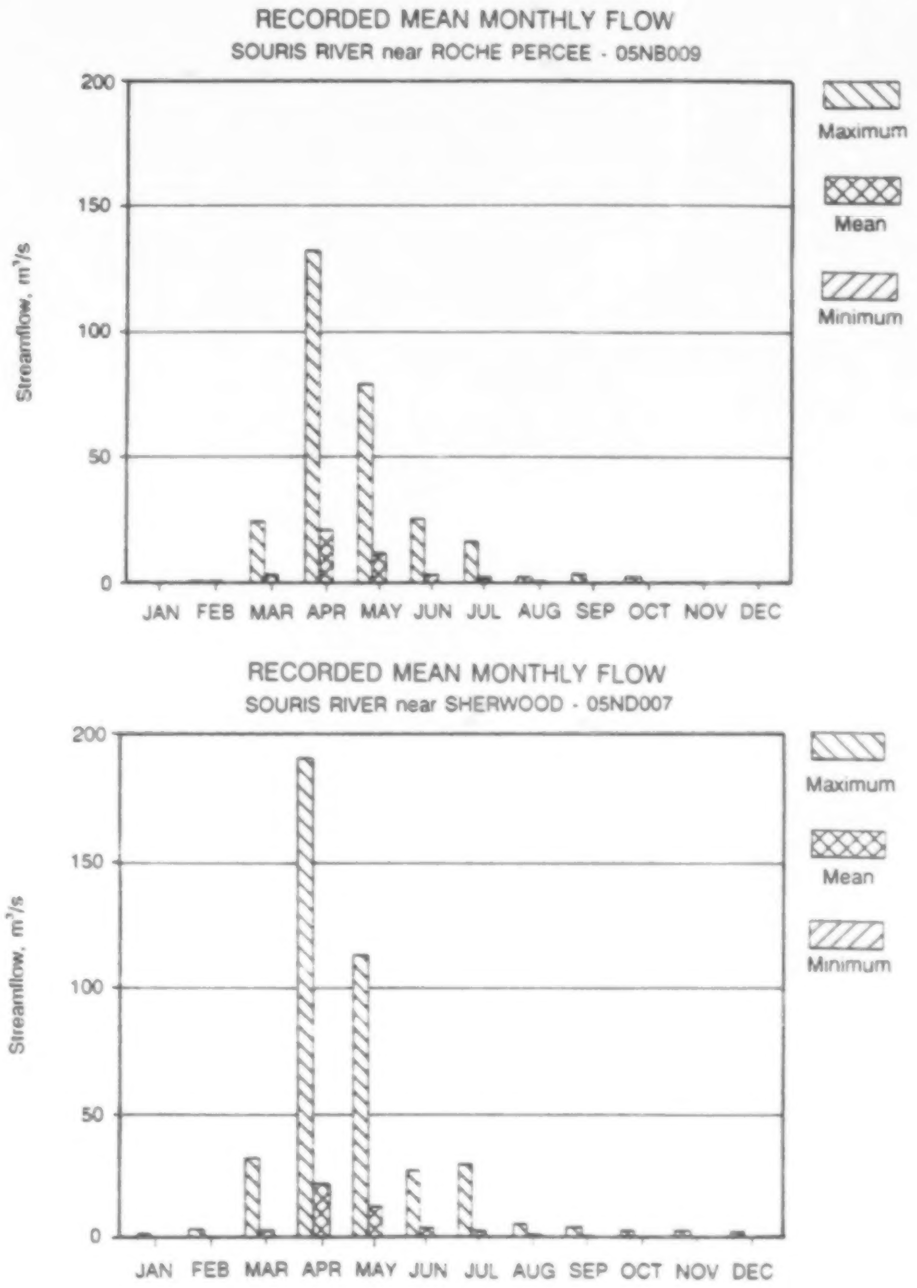
> hereinafter: provided, that in delivering such water to Manitoba no account shall be taken of water crossing the boundary at a rate in excess of the said 20 cubic feet per second.
>
> 3. (b) In periods of severe drought when it becomes impracticable for the State of North Dakota to provide the foregoing regulated flows, the responsibility of the State of North Dakota in this connection shall be limited to the provision of such flows as may be practicable, in the opinion of the said Board of Control, in accordance with the objective of making water available for human and livestock consumption and for household use. It is understood that in the circumstances contemplated in this paragraph the State of North Dakota will give the earliest possible advice to the International Souris River Board of Control with respect to the onset of severe drought conditions."

5.2 Existing Conditions

5.2.1 Saskatchewan

The stream flow regime in the Souris River basin is subject to extreme variations from month to month and also from year to year (Figures 5.1 and 5.2). For example, the total annual flow record for the Souris River near Sherwood for the period 1931 to 1988 ranges from a minimum of 448 dam^3 (in 1988) to a maximum of 776 000 dam^3 (in 1976). It is of interest to note that the 1988 volume of 448 dam^3 is approximately one-tenth of the Shand Thermal Generating Station annual requirement from Rafferty. The mean volume for that 58 year period was 120 000 dam^3 with 80 percent occurring during the March to May period.

The **mean monthly** flows on Moose Mountain Creek near Oxbow (Figure 5.2) for the period 1933 to 1981 ranged from a maximum of 51.5 m^3/s to zero with a mean annual flow of 1.03 m^3/s. Moose Mountain Creek contributes approximately 25 percent of the total discharge on the Souris River at the Saskatchewan-North Dakota boundary. The mean annual flow of the Souris River is about 4 m^3/s.



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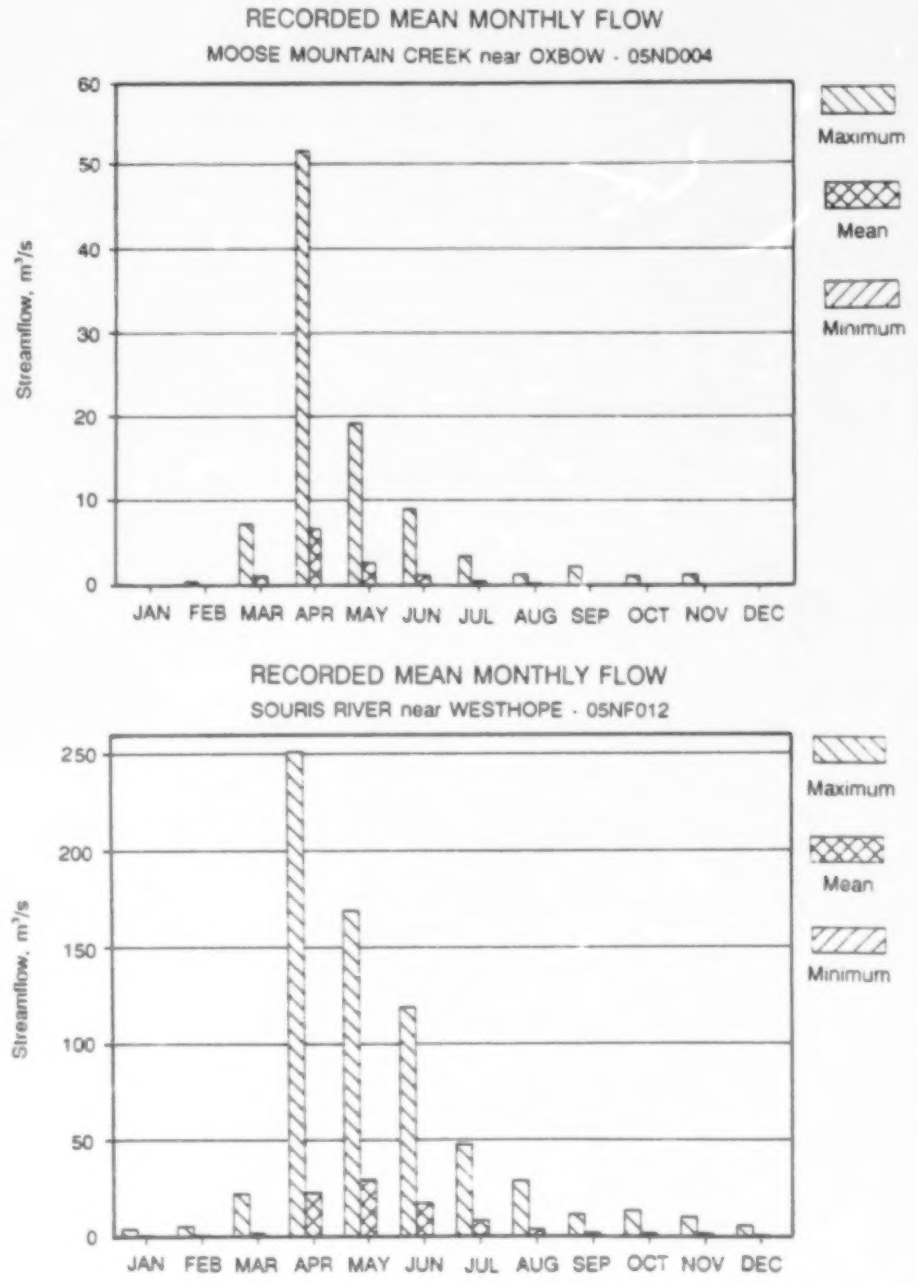
Conservation et Protection

Rafferty - Alameda Project
Initial Environmental Evaluation

FIGURE: 5.1 Recorded Mean Monthly Flow

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection



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Rafferty - Alameda Project
Initial Environmental Evaluation

FIGURE: 5.2 Recorded Mean Monthly Flow

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

Natural stream flow computations from 1959 to 1988 at the Saskatchewan-North Dakota boundary indicate that Saskatchewan has delivered to North Dakota 101 percent of the total natural stream flow at Sherwood since 1959. On only one occasion, in 1977, did Saskatchewan need to make a release in order to meet the minimum flow requirement (4 cfs) at the Sherwood Crossing.

5.2.2 North Dakota

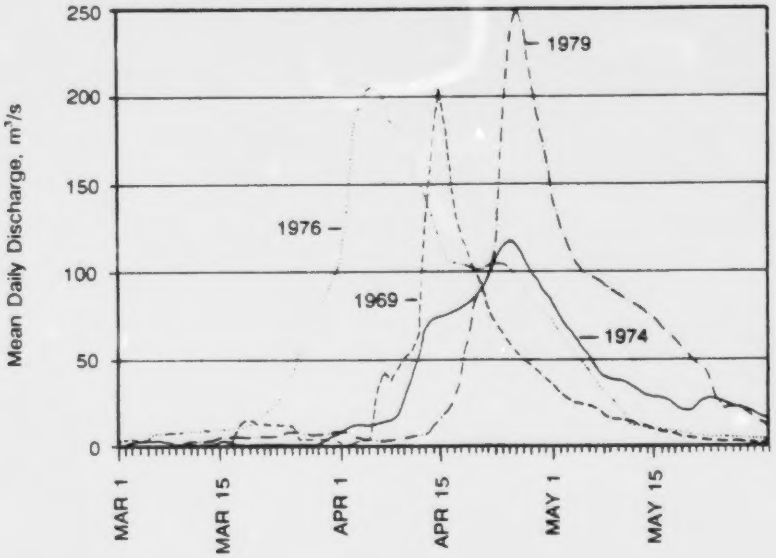
The earliest recorded flood in the Souris River occurred in 1882 at Minot, North Dakota. Newspapers also reported high flows in 1904 at Minot, as well as at Melita and Wawanesa in Manitoba. The 1976 flood produced the highest runoff volume on record. Recently, significant floods occurred in in 1969, 1974, 1975, 1976 and 1979 (Figures 5.3 and 5.4).

Water control structures in the three national wildlife refuges in the U.S. part of the Souris River basin include dams, dykes, and other works designed to maintain pools managed in the interest of migratory waterfowl (Figure 5.5). The Upper Souris NWR, located upstream of Minot, provides a total storage capacity of about 144 000 dam^3 of which 138 000 dam^3 are in Lake Darling and 6000 dam^3 are in six refuge pools. Lake Darling is operated primarily to provide supplemental water supplies to the downstream refuge pools, but it is drawn down in advance of forecast spring floods to ensure the safety of the Lake Darling Dam.

5.2.3 Manitoba

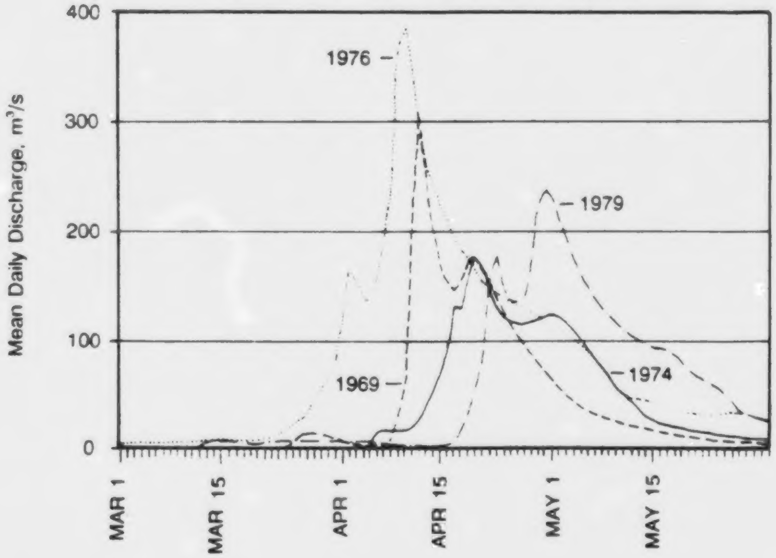
In Manitoba, eight small dams on the Souris River and its tributaries supply water for domestic, municipal and stock watering uses. Flow in the Souris River in Manitoba, as in Saskatchewan and North Dakota, is highly dependent on spring runoff with some delayed effects from upstream flow releases. For the 1936-1976 period of record, the mean annual flow rate at Wawanesa was 10.4 m^3/s. Monthly mean flows ranged from a maximum of 387 m^3/s at Melita and 488 m^3/s at Wawanesa to a minimum of zero flow at both locations. Daily mean flows were recorded for the same 41-year period at a maximum of 555 m^3/s and 742 m^3/s respectively at Melita and Wawanesa. Periods of zero flow were also recorded at both locations.

Under the 1959 Interim Measures, Manitoba is to receive 7486 dam^3 at a rate of 0.566 m^3/s during the months of June to October inclusive, except during years of severe drought when flows may be reduced. Historically, Manitoba has received more than its entitlement. For the 30 year period 1959 to 1988, Manitoba received on an average 88 000 dam^3 for the months of June to October. The median volume for this period was 36 940 dam^3 with a range of 3680 to 497 000 dam^3. The minimum flow was not achieved in 1961 or 1962.



RECORDED HYDROGRAPHS

SOURIS RIVER near ROCHE PERCEE - 05NB009



RECORDED HYDROGRAPHS

SOURIS RIVER near SHERWOOD - 05ND007

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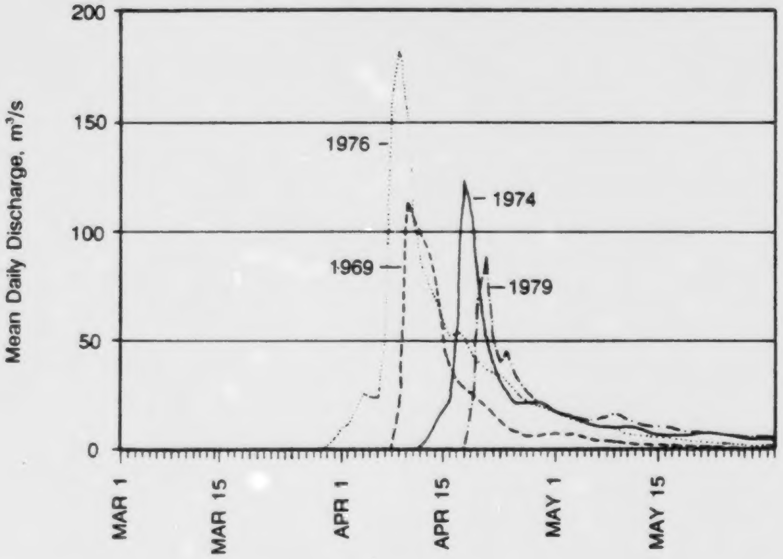
FIGURE: 5.3 Recorded Flood Hydrographs

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

RECORDED HYDROGRAPHS
MOOSE MOUNTAIN CREEK near OXBOW - 05ND004



RECORDED HYDROGRAPHS
SOURIS RIVER near WESTHOPE - 05NF012

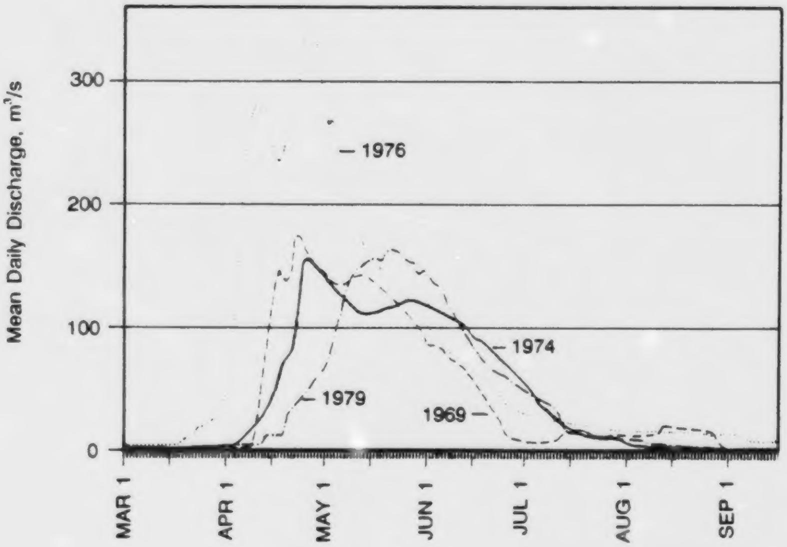


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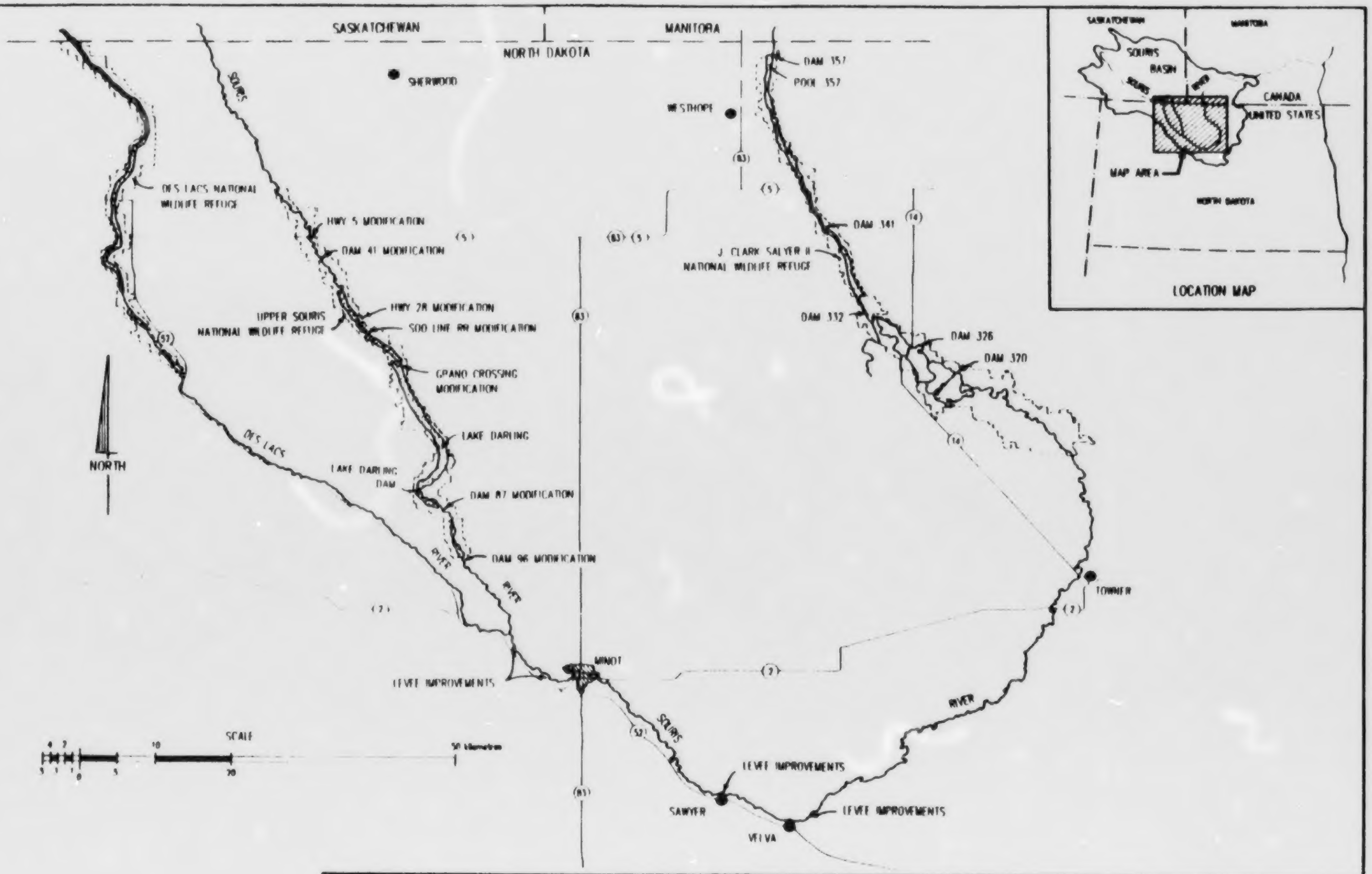
FIGURE: 5.4 Recorded Flood Hydrographs

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection



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DATE: July, 1989

Rafferty - Alameda Project
Initial Environmental Evaluation

FIGURE: 5.5 Map of Souris River, North Dakota

SOURCE: Environment Canada Conservation and Protection

5.3 Project Impacts

5.3.1 Operation Plan

On January 13, 1989, representatives from the governments of Canada, United States, Saskatchewan, North Dakota and Manitoba agreed upon a draft operating plan for the Project in Saskatchewan together with coordinated operation in North Dakota. The objectives of the draft operating plan are:

- to provide one percent (100-year) flood protection at Minot, North Dakota,
- to provide flood protection to urban and rural areas downstream from Rafferty Dam, Alameda Dam and Lake Darling Dam,
- to ensure, to the extent possible, that the existing benefits from the supply of water in the Souris River basin and the supply of water to the Souris basin project are not compromised.

Within the water supply objective of the plan, Saskatchewan would operate the Rafferty and Alameda Dams to:

- comply with international apportionment obligations,
- provide water for existing authorized uses in Saskatchewan,
- provide water for the Shand Thermal Generating Station, and
- provide water for new authorized uses in Saskatchewan.

Flow passed to North Dakota would be either a minimum of 40 or 50 percent of the natural flow at Sherwood Crossing depending on whether the year is wet or dry. The 1959 Interim Measures must be modified to facilitate the storage of up to 60 percent of the natural flow by Saskatchewan.

The proposed flood operating plan is divided into four phases:

- reservoir lowering prior to spring runoff,
- operations during runoff,
- operations after runoff to restore reservoirs to FSL, and
- operations during summer, fall and winter.

Hydrologic impacts of the Project were analyzed using a computerized water balance model. Two major variables were considered in the modelling process. These were:

- the inclusion or exclusion of the proposed 4800 ha of irrigation, and
- whether the 60/40 or 50/50 apportionment rule is applied.

Combinations of these two variables provided four scenarios which were analyzed. Of these four possible scenarios, the 50/50 apportionment with the additional 4800 ha of irrigation development (Y2C5I) would be the most likely operating plan. A preliminary assessment of the apportionment rules suggests that over a 60 year period the 60/40 apportionment rule would be imposed in only about one-third of those years. Full level of irrigation development with 60/40 apportionment (Y2C4I) presents the largest use scenario in Saskatchewan.

5.3.2 Saskatchewan

The impact of the Rafferty and Alameda dams would include flooding upstream of the dams and a changed hydrologic regime downstream of the dams. In Saskatchewan these impacts would be both positive and negative. The reservoirs would regulate the natural extreme variable flows of the river by reducing the peak discharges during spring floods and increasing flows throughout the remaining part of the year. This means that water would be available for such uses as power plant cooling water, irrigation, municipal water supply and recreation in Saskatchewan.

Mean flows for the Souris River near Sherwood for all simulations, observations and natural flow computations are shown for five different time periods in Table 5.1. The reasons for the various divisions of the mean flows are as follows:

1912-1981	The Y2C40, Y2C4I, Y2C50, Y2C5I simulations are the SBDA EIS computer runs for Saskatchewan.
1912-1974	The C41A, C51A simulations were two of several computer runs conducted to determine the flows through North Dakota to Westhope for the negotiations on the Operating Plan between Canada and United States. The May 1989 E55A and J55A are also prepared for this period.
1931-1974	1931 was the beginning of recorded daily flows of the Souris River near Sherwood and Westhope.
1959-1974	The International Souris River Board of Control began computing annual natural flows at Sherwood and monitoring the low flows at Westhope.

The SBDA EIS used modelling runs Y2C50, Y2C5I, Y2C40, Y2C4I starting with the Saskatchewan reservoirs nearly full to provide an envelope of simulations that would include the four combinations of operation with 50/50 or 60/40 apportionment with full or no irrigation. Rafferty and Alameda reservoir levels vary mainly because of climatic variation (Figures 5.6 and 5.7).

For all four of the SBDA scenarios, total annual flow would be reduced from historical volumes at the international boundary crossings at Sherwood. A comparison of historical and simulated monthly mean discharges is shown in Figure 5.8. Flow reduction in the Project simulations varies from 34 to 46 percent of the total natural flow at Sherwood depending on the amount of apportionment flow required and on the amount of new irrigation. This means that 54 to 66 percent of the **total** historic flow would be delivered to North Dakota for the period 1912 to 1974. At least 50 percent of the flow would be delivered to North Dakota every year for the four scenarios.

MEAN FLOWS FOR SHERWOOD (Apportionment Channel 100)

	JAN (cu.m/s)	FEB (cu.m/s)	MAR (cu.m/s)	APR (cu.m/s)	MAY (cu.m/s)	JUN (cu.m/s)	JUL (cu.m/s)	AUG (cu.m/s)	SEP (cu.m/s)	OCT (cu.m/s)	NOV (cu.m/s)	DEC (cu.m/s)	TOTAL (cu.dams)
1912-1981													
Y2C40	.082	.144	1.423	6.520	5.024	14.201	2.575	.449	.367	.380	.405	.514	84042
Y2C41	.069	.130	1.434	6.514	4.851	9.441	1.765	.594	.615	.699	.734	.771	72442
Y2C50	.081	.138	1.558	7.316	5.140	11.977	2.489	.582	.621	.712	.818	.824	84561
Y2C51	.068	.132	1.567	7.311	4.878	7.508	1.617	.893	.960	1.122	1.192	1.211	74729
1912-1974													
C41A	.061	.056	1.500	6.295	4.875	6.546	2.023	1.270	.597	.453	.227	.092	55296
C51A	.057	.054	1.704	6.846	5.017	4.066	1.894	1.018	.503	.349	.187	.188	57544
E55A	.058	.058	1.699	6.846	5.015	3.968	1.811	.764	.202	.179	.196	.189	55224
J55A	.070	.068	2.502	18.347	9.504	3.427	2.178	.486	.190	.339	.168	.084	98138
Y2C40	.070	.066	1.360	4.861	3.145	10.647	2.498	.451	.297	.340	.406	.504	64595
Y2C41	.055	.050	1.372	4.868	3.089	5.547	1.721	.616	.570	.680	.746	.789	52818
Y2C50	.067	.059	1.466	5.608	3.296	8.326	2.407	.588	.575	.700	.828	.837	64965
Y2C51	.052	.052	1.476	5.617	3.243	3.576	1.554	.919	.942	1.139	1.244	1.268	55465
1931-1974													
C41A	.066	.071	1.657	5.826	4.953	3.803	1.985	1.480	.822	.605	.291	.101	57072
C51A	.059	.066	1.910	6.339	4.888	4.224	2.156	1.270	.682	.453	.199	.220	59166
E55A	.061	.072	1.903	6.340	4.885	4.225	2.058	.904	.251	.210	.239	.220	56258
J55A	.068	.082	2.830	18.573	9.361	3.314	2.214	.474	.223	.378	.191	.081	99266
Y2C40	.067	.079	1.462	4.865	3.135	10.864	2.511	.448	.361	.410	.485	.552	66152
Y2C41	.057	.062	1.479	4.873	3.075	5.978	1.821	.614	.598	.716	.759	.772	54650
Y2C50	.066	.074	1.593	5.582	3.279	8.466	2.483	.613	.654	.782	.897	.865	66539
Y2C51	.053	.064	1.608	5.588	3.224	4.302	1.494	.879	.939	1.143	1.223	1.227	57182
Recorded	.063	.065	3.384	18.589	9.089	3.609	2.324	.601	.326	.273	.272	.118	101703
1959-1974													
C41A	.052	.064	2.439	5.938	5.755	4.072	1.519	1.096	1.121	.576	.156	.075	60241
C51A	.054	.063	2.668	6.444	5.067	4.671	2.187	1.271	.712	.292	.198	.189	62732
E55A	.054	.065	2.667	6.443	5.069	4.670	2.184	.429	.323	.290	.199	.188	59458
J55A	.070	.084	4.192	20.976	11.028	2.565	1.573	.362	.241	.446	.150	.035	109663
Y2C40	.054	.064	2.231	5.518	3.467	12.105	1.742	.357	.367	.454	.519	.711	72277
Y2C41	.051	.064	2.234	5.518	3.396	5.501	.907	.832	.850	.870	.826	.951	57810
Y2C50	.053	.065	2.404	6.128	3.621	9.597	1.665	.440	.797	1.022	.993	.914	72660
Y2C51	.053	.065	2.404	6.128	3.561	3.310	1.256	1.059	1.115	1.412	1.463	1.461	61321
Natural	-	-	-	-	-	-	-	-	-	-	-	-	116094
Recorded	.066	.049	4.224	19.839	10.886	3.538	1.761	.514	.411	.346	.316	.114	110572
1959-1988													
Natural	-	-	-	-	-	-	-	-	-	-	-	-	138202
Recorded	-	-	-	-	-	-	-	-	-	-	-	-	159357

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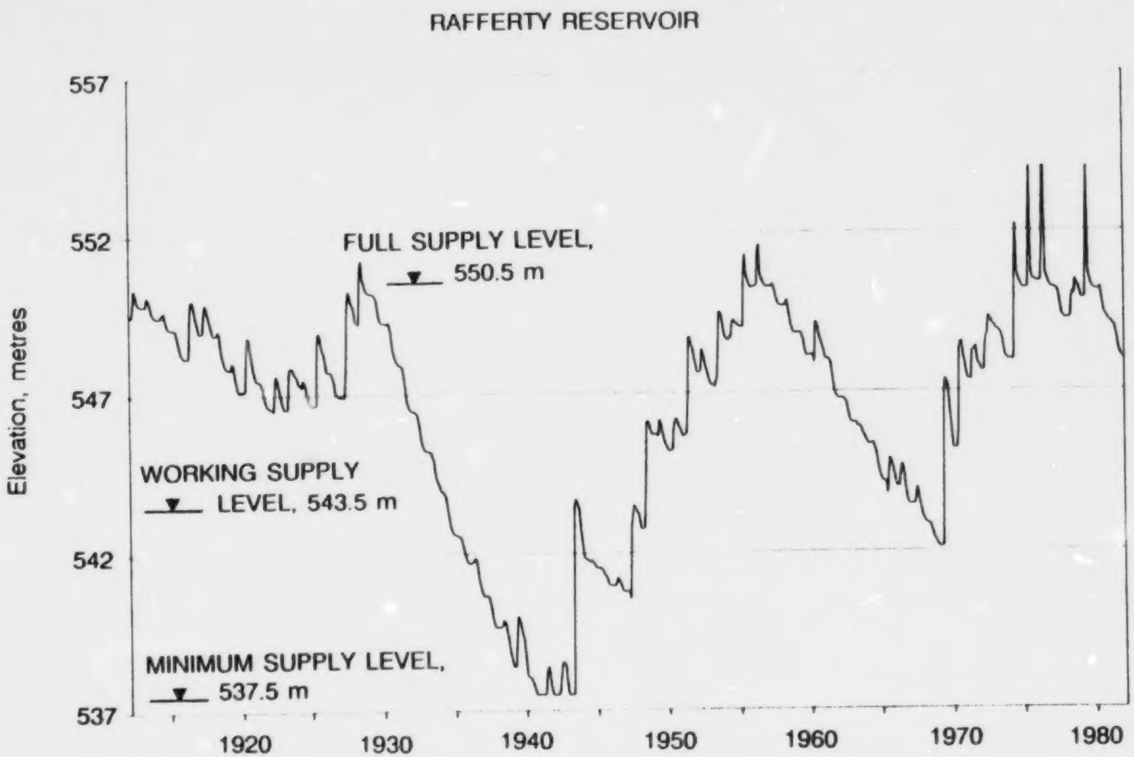
Initial Environmental Evaluation

TABLE: 5.1 Mean Flows for Sherwood

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection



Note
- Model run E55A assumed
a starting reservoir
elevation of 549.5 m

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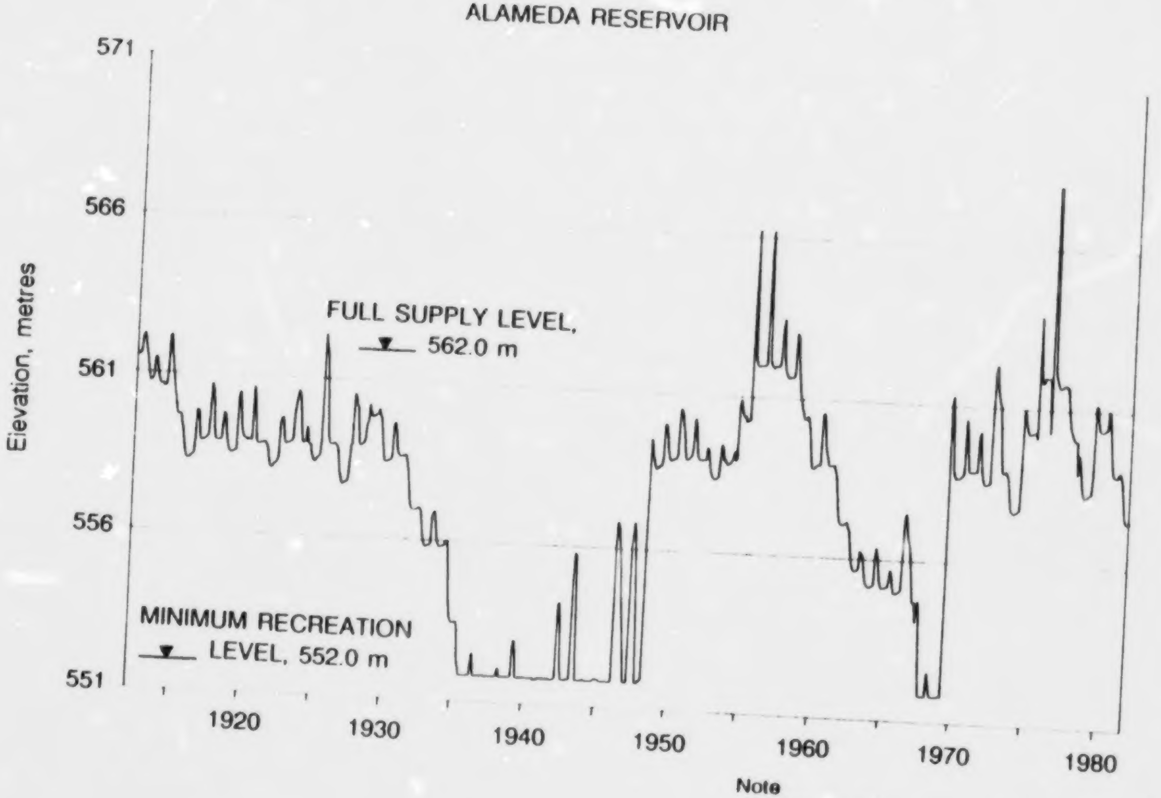
	FIGURE: 5.6 Rafferty Reservoir Levels E55A
DATE: July, 1989	**SOURCE:** Environment Canada Conservation and Protection



Note
- Model run E55A assumed
a starting reservoir
elevation of 561.5 m

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DATE: July, 1989

Rafferty – Alameda Project
Initial Environmental Evaluation

FIGURE: 5.7 Alameda Reservoir Levels E55A

SOURCE: Environment Canada Conservation and Protection

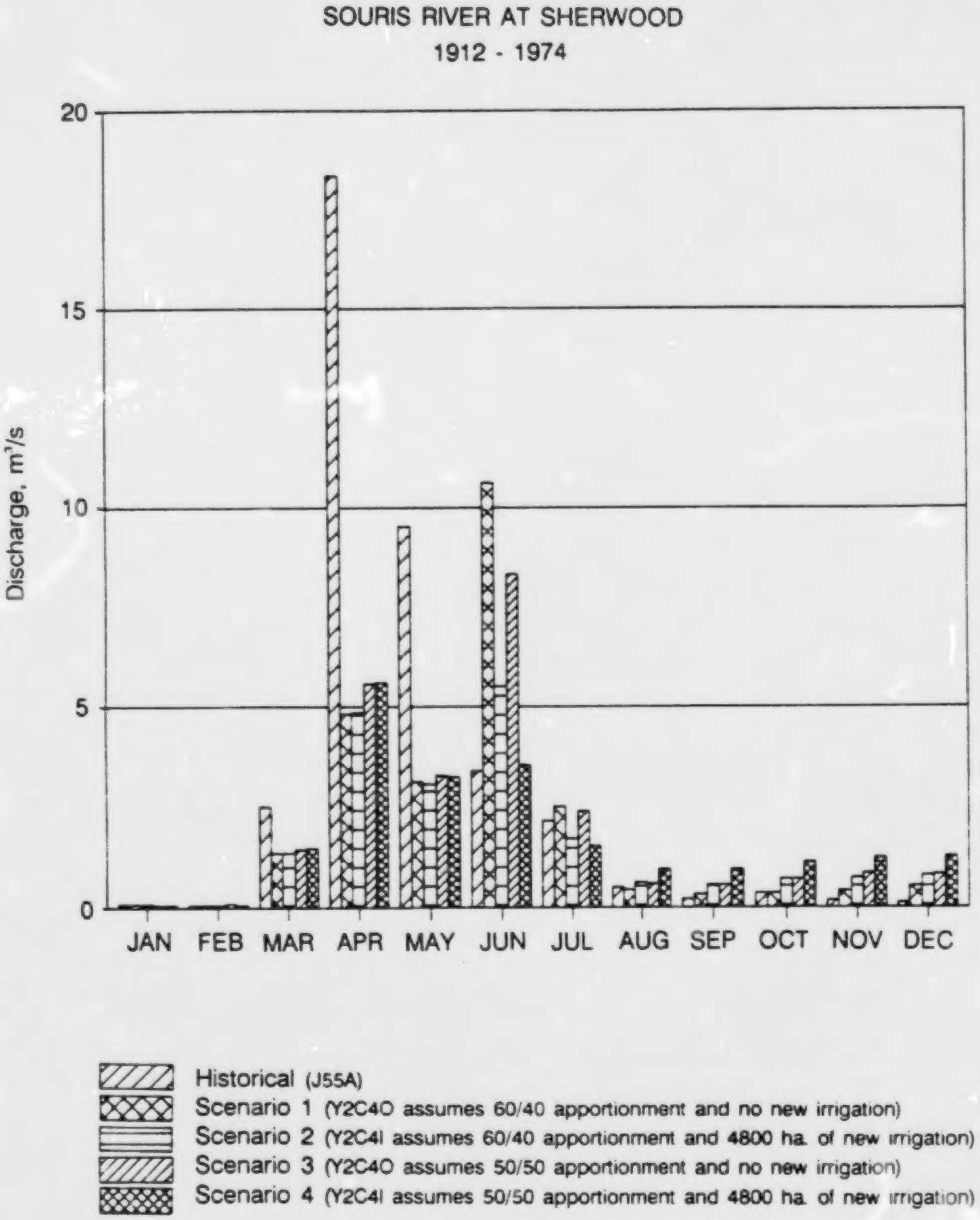

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FIGURE: 5.8 Discharge Comparison at Sherwood

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

Simulations of the hydrologic system indicate that 4640 dam³ of water from Rafferty Reservoir would be available for the Shand Thermal Generating Station throughout the study period except perhaps during the first part of the initial filling period. In addition to existing uses irrigation of 4800 ha using 6000 dam³ of water annually could be supported 80 percent of the time from Rafferty Reservoir. The operating scenarios assumed that there would be no irrigation until Rafferty reservoir reached the working supply level, 543.5 m.

Two computer simulations were conducted to show the difference in Project impacts of retaining 60 percent of the peak natural flows (C41A) and 50 percent of peak natural flow (C51A) both under 4800 ha of irrigation development. The flow with run C41A reduced flows by four percent for the period 1912 to 1974 (Table 5.1) below run C51A.

The updated computer simulation of the Project (E55A) conducted for this IEE using data corresponding to present operating conditions was compared to simulated historic conditions. Tables 5.2 and 5.3 provide mean monthly flows at Sherwood for simulated historic and Project conditions, while Table 5.4 provides the difference between the two tables. The Project would result in an average annual flow at Sherwood of 55 224 dam³ as compared to 98 138 dam³ without the Project (J55A). In this case 56 percent of the simulated historic flow would be delivered at Sherwood for the period 1912 to 1974. For the period 1959 to 1974 the Project (E55A) would deliver 59 458 dam³ at Sherwood compared to the natural flow of 116 094 dam³ or 51 percent. It should also be noted that for the period 1959 to 1974 the simulated historic flow (J55A) of 109 663 dam³ is 94 percent of the natural flow. The actual recorded flow at Sherwood is 110 494 dam³ which indicates that the updated values used in the modelling (J55A) reduced the flow at Sherwood by one percent.

The greatly increased water surface area presented by the reservoirs would increase evaporation losses and therefore reduce the total flow in the Souris River below the dams. For example, in 1955, Rafferty Reservoir would have had a net loss to evaporation of 14 800 dam³ at FSL while Alameda Reservoir would have lost 800 dam³ at FSL. If the reservoirs were at the working supply levels in 1955, they would have lost 10 200 dam³ and 200 dam³ respectively. In 1937 the losses to net evaporation at Rafferty and Alameda would have been 36 500 dam³ and 8500 dam³, respectively, at FSL and 25 000 dam³ and 2500 dam³, respectively, at the working levels. Since 1955 was a relatively wet year with a lower net evaporation, less water would have been lost to the atmosphere than during the drier year, 1937.

SHERWOOD FLOW SIMULATED HISTORIC (J55A) Flow = m^3/sec, Total = dam^3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
12	.046	.000	1.293	10.003	16.342	4.148	1.503	.220	.176	.701	.115	.363	92255.
13	.022	.342	3.144	13.500	2.049	1.112	.625	.217	.047	.108	.021	.015	55430.
14	.000	.002	5.060	8.725	3.072	4.955	1.208	.305	.030	.177	.000	.071	62039.
15	.000	.056	.189	.163	.278	.049	.149	.019	.018	.204	.000	.022	3038.
16	.015	.155	.000	31.187	22.435	5.568	1.512	.361	.609	.820	.350	.046	165596.
17	.024	.017	1.468	17.332	15.999	1.705	1.648	.171	.000	.210	.000	.001	101670.
18	.000	.000	6.119	2.219	1.556	.437	.010	.139	.173	.214	.076	.000	29059.
19	.044	.009	.025	25.110	3.486	.000	.000	.000	.000	.179	.019	.000	75157.
20	.001	.013	.000	30.146	18.337	1.874	1.937	.104	.009	.153	.007	.101	138332.
21	.007	.001	.499	.793	.674	1.059	.604	.313	.183	.471	.354	.036	13169.
22	.094	.018	.349	23.930	8.733	4.833	2.136	.324	.019	.140	.000	.020	106241.
23	.006	.022	.160	30.376	14.150	7.613	3.038	.703	.000	.094	.093	.250	148047.
24	.184	.000	5.501	2.129	1.922	2.908	1.107	.230	.096	.467	.603	.203	40618.
25	.093	.000	3.527	56.031	9.429	3.568	1.398	.560	.021	.163	.026	.001	195236.
26	.108	.000	.024	2.716	1.250	1.783	.433	2.527	.027	.220	.049	.044	24195.
27	.069	.048	3.014	33.761	52.183	21.594	8.702	1.360	.387	.000	.196	.306	320902.
28	.364	.000	1.318	40.415	11.183	4.251	10.842	.926	.118	.124	.259	.225	183663.
29	.296	.012	.804	1.706	1.765	2.006	2.247	1.237	.206	.148	.010	.000	27612.
30	.012	.000	.602	8.443	2.020	.617	.679	.016	.000	.117	.011	.007	32761.
31	.004	.007	.000	.340	.295	.005	.035	.017	.000	.168	.000	.000	2301.
32	.000	.008	.000	.860	.490	.301	.156	.035	.000	.062	.000	.008	5040.
33	.005	.035	5.595	4.208	.000	7.202	.234	.141	.024	.246	.026	.010	46478.
34	.009	.141	4.918	1.133	.380	.055	.040	.004	.003	.170	.000	.000	18216.
35	.002	.001	.052	.798	.804	.127	.797	.064	.008	.192	.000	.000	7539.
36	.003	.009	.000	8.776	3.787	.474	.036	.005	.003	.190	.000	.000	34775.
37	.008	.002	.000	.398	.193	.000	.000	.010	.010	.178	.012	.000	2135.
38	.016	.007	5.278	3.495	.871	.178	.023	.015	.007	.204	.000	.000	26716.
39	.022	.016	8.654	14.043	.960	.232	.316	.056	.006	.106	.000	.000	64144.
40	.000	.002	.000	.770	.525	.062	.014	.015	.008	.098	.000	.000	3928.
41	.021	.025	.000	6.384	2.365	.784	.274	.109	.000	.240	.000	.013	26734.
42	.000	.029	2.855	15.835	3.964	1.138	.857	.518	.119	.361	.115	.039	67689.
43	.065	.027	.000	82.041	10.431	4.690	1.866	.671	.468	.354	.198	.159	262880.
44	.101	.101	.033	1.596	.830	2.996	8.972	1.386	.617	.451	.285	.102	46291.
45	.032	.013	.301	.921	.575	.284	.541	.225	.031	.213	.100	.023	8610.
46	.022	.010	13.416	7.877	.850	.618	.254	.184	.094	.169	.044	.028	62371.
47	.048	.020	.000	46.065	11.371	8.580	3.685	.589	.375	.308	.148	.199	186434.
48	.196	.103	.146	41.339	73.275	4.556	2.304	1.170	.350	.394	.397	.194	329201.
49	.077	.053	.000	21.325	1.936	1.511	.574	.391	.171	.430	.264	.109	69867.
50	.074	.079	1.415	21.583	10.504	3.339	1.499	1.060	.262	.298	.211	.147	106183.
51	.193	.210	.137	31.861	44.188	3.732	.858	.543	.221	.671	.410	.145	219576.
52	.054	.115	.546	18.483	2.001	.596	.524	.157	.049	.226	.146	.103	59908.
53	.104	.080	2.066	10.338	4.229	25.738	28.053	3.834	.920	.493	.536	.404	202424.
54	.231	.719	2.222	4.042	3.218	17.004	6.903	.614	1.082	1.560	1.812	.705	105181.
55	.290	.206	.000	63.566	35.052	15.067	6.522	1.349	.504	.868	.574	.261	325875.
56	.102	.115	3.147	54.066	17.604	4.268	6.487	1.639	.353	.603	.500	.232	233545.
57	.120	.062	3.088	8.432	3.044	1.116	.430	.281	.289	.257	.232	.128	45930.
58	.078	.053	3.559	10.996	1.667	.102	.000	.003	.000	.000	.000	.000	43109.
59	.025	.051	4.280	1.390	.468	.477	.351	.086	.009	.851	.492	.187	22996.
60	.179	.109	4.878	40.409	4.364	.739	.256	.199	.000	.185	.000	.000	133867.
61	.000	.019	.886	.761	.297	.000	.000	.026	.015	.148	.000	.000	5692.
62	.000	.107	.523	1.683	.732	1.620	.296	.004	.001	.195	.000	.000	13510.
63	.200	.282	1.726	1.032	1.061	1.733	2.050	1.038	1.067	.330	.000	.043	27885.
64	.092	.105	.137	8.156	2.924	.852	.691	.098	.000	.247	.000	.000	34823.
65	.002	.002	.000	5.408	13.396	14.005	1.959	.564	.113	.448	.154	.080	95072.
66	.088	.005	11.604	9.758	1.970	.629	.083	.000	.030	.183	.000	.000	64318.
67	.000	.000	.000	6.434	6.828	.300	.000	.004	.001	.178	.000	.000	36233.
68	.029	.019	3.382	1.060	.375	.005	.023	.000	.281	.164	.000	.000	14176.
69	.058	.026	.000	112.802	20.116	.697	3.855	.841	.069	.476	.149	.058	362859.
70	.092	.212	1.037	15.995	55.830	7.481	3.662	.866	.688	.998	.390	.020	231570.
71	.047	.128	1.060	25.275	6.546	.709	6.382	.223	.000	1.662	.645	.103	112248.
72	.139	.131	35.982	21.965	4.162	9.360	1.834	1.067	1.214	.364	.471	.000	202518.
73	.148	.075	1.580	.794	.756	.422	.152	.104	.196	.274	.036	.020	12061.
74	.028	.071	.000	82.701	56.628	2.013	3.570	.667	.175	.436	.068	.053	384786.
MAX	.364	.719	35.982	112.802	73.275	25.738	28.053	3.834	1.214	1.662	1.812	.705	384786.
MIN	.000	.000	.000	.163	.000	.000	.000	.000	.000	.000	.000	.000	2135.
MEAN	.070	.068	2.502	18.347	9.504	3.427	2.178	.486	.190	.339	.168	.084	98138.

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TABLE: 5.2 Sherwood Flow Simulated Historic (J55A)

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SHERWOOD FLOW PROJECT (E55A) Flow = m^3/sec, Total = dam^3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
12	.024	.005	.942	5.378	7.363	2.779	.821	.099	.112	.459	.230	.346	68970.
13	.009	.184	2.382	6.124	1.250	1.498	.356	.171	.047	.000	.089	.133	32074.
14	.002	.004	3.275	5.210	2.039	2.265	.757	.247	.000	.002	.000	.168	36768.
15	.014	.041	.188	.163	.135	.109	.030	.030	.030	.030	.030	.030	2184.
16	.015	.086	.065	14.160	10.344	4.969	.370	.370	.576	.525	.234	.148	83594.
17	.021	.016	.891	10.005	5.126	3.230	1.095	.171	.000	.023	.000	.000	53968.
18	.000	.005	3.557	1.603	1.321	1.321	.034	.139	.173	.063	.050	.000	21866.
19	.034	.017	.027	14.717	1.628	1.104	.014	.014	.016	.014	.014	.013	45793.
20	.001	.009	.000	14.160	7.740	4.404	1.489	.104	.009	.000	.003	.058	73326.
21	.007	.001	.448	.846	.562	1.175	.360	.360	.360	.360	.360	.360	13688.
22	.057	.006	.539	12.198	3.624	3.291	2.054	.324	.000	.000	.000	.000	57834.
23	.014	.014	.295	14.160	7.359	4.371	.691	.438	.000	.000	.104	.363	72870.
24	.124	.006	4.062	1.371	1.251	1.606	.867	.000	.003	.262	.434	.138	26820.
25	.064	.016	2.326	14.160	13.349	6.047	.992	.241	.000	.000	.018	.000	97920.
26	.078	.000	.074	2.716	1.010	1.216	.325	2.182	.000	.197	.034	.030	20715.
27	.049	.038	2.000	14.160	19.625	14.160	6.874	1.274	.000	.000	.000	.197	153900.
28	.258	.000	1.180	14.160	14.160	7.905	4.629	.926	.118	.038	.183	.158	115154.
29	.209	.000	.515	1.706	1.665	1.143	1.761	1.180	.185	.000	.007	.000	22158.
30	.010	.013	.575	5.361	1.494	1.494	.050	.050	.050	.050	.050	.050	24163.
31	.005	.005	.019	.340	.240	.000	.035	.017	.000	.000	.000	.000	1740.
32	.004	.005	.041	.816	.255	.237	.100	.033	.000	.003	.034	.034	4088.
33	.009	.034	3.500	3.820	.575	4.831	.226	.141	.024	.039	.018	.006	34657.
34	.008	.098	4.522	.867	.266	.000	.030	.004	.003	.000	.000	.000	15429.
35	.005	.005	.052	.791	.589	.291	.091	.091	.091	.091	.091	.091	5994.
36	.005	.006	.005	7.186	1.801	1.801	.036	.005	.003	.000	.010	.011	28332.
37	.005	.006	.005	.398	.182	.000	.004	.010	.010	.010	.012	.008	1703.
38	.011	.012	4.346	1.971	1.053	1.505	.023	.015	.011	.016	.016	.016	23786.
39	.015	.009	7.685	7.678	.879	.709	.315	.056	.006	.000	.000	.000	45748.
40	.012	.013	.036	.731	.462	.062	.014	.015	.008	.005	.000	.000	3565.
41	.014	.017	.043	5.895	1.492	1.492	.258	.109	.000	.016	.000	.057	24516.
42	.014	.014	2.224	8.133	2.615	2.615	.474	.114	.085	.188	.216	.216	44328.
43	.052	.032	.139	14.160	14.160	14.160	3.251	.554	.468	.165	.308	.373	125564.
44	.068	.065	.087	1.596	.482	2.149	7.153	.559	.513	.231	.203	.052	34840.
45	.036	.035	.285	.914	.455	.179	.258	.215	.031	.037	.136	.136	7159.
46	.014	.014	6.906	3.529	1.284	2.388	.186	.136	.067	.053	.037	.096	38875.
47	.034	.011	.615	14.160	11.590	5.328	2.182	.589	.241	.087	.068	.199	92309.
48	.127	.101	.131	14.160	34.264	7.378	1.504	1.107	.350	.258	.281	.121	158179.
49	.050	.051	.134	9.153	2.348	2.348	.428	.231	.116	.194	.186	.072	39976.
50	.058	.056	1.077	11.881	4.071	2.455	.922	.279	.262	.143	.150	.171	56364.
51	.134	.113	.135	14.160	14.160	9.694	.792	.489	.175	.092	.265	.101	105838.
52	.054	.068	.600	7.735	2.118	2.118	.361	.151	.049	.060	.105	.107	35346.
53	.069	.049	1.391	5.477	2.226	12.943	7.621	1.686	.645	1.727	2.938	2.938	104446.
54	.150	.492	1.543	2.813	1.966	5.617	.911	.911	.911	.911	.911	.911	47324.
55	.138	.133	.154	14.160	14.160	14.160	14.160	14.160	1.489	.172	.843	.737	196767.
56	.584	.560	1.049	14.160	14.160	14.160	14.160	11.240	.217	.087	.350	.146	187185.
57	.089	.073	1.786	4.207	4.040	.649	.109	.000	.086	.036	.167	.088	29886.
58	.049	.048	2.540	4.972	1.923	1.923	.000	.003	.000	.000	.000	.000	30081.
59	.023	.036	3.374	1.096	.468	.477	.327	.086	.001	.742	.353	.122	18854.
60	.118	.067	5.995	13.110	4.872	4.872	.256	.191	.000	.004	.000	.000	77402.
61	.000	.013	.858	.761	.230	.000	.000	.026	.015	.000	.000	.000	5027.
62	.000	.075	.763	1.806	.565	1.573	.296	.004	.001	.007	.000	.000	13322.
63	.138	.196	1.205	1.391	.864	2.610	1.255	.594	.940	.119	.010	.585	26056.
64	.066	.076	.147	7.102	1.848	1.848	.529	.077	.000	.049	.000	.000	30657.
65	.014	.000	.000	5.398	6.355	6.715	.437	.437	.437	.437	.437	.437	55403.
66	.065	.004	6.604	3.023	2.480	2.480	.083	.000	.030	.000	.000	.000	39078.
67	.000	.000	1.159	4.832	2.371	1.685	.000	.004	.001	.000	.000	.000	26360.
68	.029	.020	2.371	.969	.305	.561	.091	.209	.280	.038	.136	.150	13645.
69	.043	.026	.000	19.830	14.160	14.160	14.160	2.228	.553	.553	.553	.553	175929.
70	.059	.148	.833	8.733	14.160	14.160	1.407	.520	.521	.501	.623	.623	111169.
71	.000	.123	.883	9.035	2.516	2.516	.902	.902	.902	1.588	.587	.522	53684.
72	.139	.131	16.698	11.043	3.325	6.357	.907	.841	1.150	.185	.443	.000	108726.
73	.148	.075	1.271	.794	.430	.551	.131	.104	.196	.167	.000	.000	10205.
74	.023	.047	.507	14.160	26.155	14.160	14.160	.648	.138	.243	.048	.019	185838.
MAX	.584	.560	16.698	19.830	34.264	14.160	14.160	14.160	1.489	1.727	2.938	2.938	196767.
MIN	.000	.000	.000	.163	.135	.000	.000	.000	.000	.000	.000	.000	1703.
MEAN	.058	.058	1.699	6.846	5.015	3.968	1.811	.764	.202	.179	.196	.189	55224.

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Rafferty - Alameda Project
Initial Environmental Evaluation

TABLE: 5.3 Sherwood Flow Project (E55A)

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SHERWOOD FLOW DIFFERENCE (E55A - J55A) Flow = m^3/sec, Total = dam^3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
12	-.022	.005	-.351	-4.625	-8.979	-1.369	-.682	-.121	-.064	-.242	.115	-.017	-43285.
13	-.013	-.158	-.762	-7.376	-.799	.386	-.269	-.046	.000	-.108	.068	.118	-23357.
14	.002	.002	-1.785	-3.515	-1.033	-2.690	-.451	-.058	-.030	-.175	.000	.097	-25271.
15	.016	-.015	-.001	.000	-.143	.060	-.119	.011	.012	-.174	.030	.008	-854.
16	.000	-.069	.065	-17.027	-12.091	-.599	-1.142	.009	-.033	-.295	-.116	.102	-82002.
17	-.003	-.001	-.577	-7.327	-10.873	1.525	-.553	.000	.000	-.187	.000	-.001	-47702.
18	.000	.005	-2.562	-.616	-.235	.884	.024	.000	.000	-.151	-.026	.000	-7192.
19	-.010	.008	.002	-10.393	-1.858	1.104	.014	.014	.014	-.165	-.005	.013	-29364.
20	.000	-.004	.000	-15.986	-10.597	2.530	-.448	.000	.000	-.153	-.004	-.043	-65006.
21	.000	.000	-.051	.053	-.112	.116	-.244	.047	.177	-.111	.006	.324	519.
22	-.037	-.012	.190	-11.732	-5.109	-1.542	-.082	.000	-.019	-.140	.000	-.020	-48407.
23	.008	-.008	.135	-16.216	-6.791	-3.242	-2.347	-.265	.000	-.094	.011	.113	-75177.
24	-.060	.006	-1.439	-.758	-.671	-1.302	-.240	-.230	-.093	-.205	-.169	-.065	-13798.
25	-.029	.016	-1.201	-41.871	3.920	2.479	-.406	-.319	-.021	-.163	-.008	-.001	-97317.
26	-.030	.000	.050	.000	-.240	-.567	-.108	-.345	-.027	-.023	-.015	-.014	-3480.
27	-.020	-.010	-1.014	-19.601	-32.558	-7.434	-1.828	-.086	-.387	.000	-.196	-.109	-167001.
28	-.106	.000	-.138	-26.255	2.977	3.654	-6.213	.000	.000	-.086	-.076	-.067	-68509.
29	-.087	-.012	-.280	.000	-.100	-.863	-.486	-.057	-.021	-.148	-.003	.000	-5454.
30	-.002	.013	-.027	-3.082	-.526	.877	-.629	.034	.050	-.067	.039	.043	-8598.
31	.001	-.002	.019	.000	-.055	-.005	.000	.000	.000	-.168	.000	.000	-562.
32	.004	-.003	.041	-.044	-.235	-.064	-.056	-.002	.000	-.059	.034	.026	-952.
33	.004	-.001	-2.095	-.388	.575	-2.371	-.008	.000	.000	-.207	-.008	-.004	-11822.
34	-.001	-.043	-.396	-.266	-.116	-.055	-.010	.000	.000	-.170	.000	.000	-2787.
35	.003	.004	.000	-.007	-.215	.164	-.706	.027	.083	-.101	.091	.091	-1546.
36	.002	-.003	.005	-1.590	-1.986	1.327	.000	.000	.000	-.190	.010	.011	-6443.
37	-.003	.004	.005	.000	-.011	.000	.004	.000	.000	-.168	.000	.008	-632.
38	-.005	.005	-.932	-1.524	.182	1.327	.000	.000	.004	-.188	.016	.016	-2930.
39	-.007	-.007	-.969	-6.365	-.081	.477	-.001	.000	.000	-.106	.000	.000	-18396.
40	.012	.011	.036	-.039	-.063	.000	.000	.000	.000	-.093	.000	.000	-364.
41	-.007	-.008	.043	-.489	-.873	.708	-.016	.000	.000	-.224	.000	.044	-2218.
42	.016	-.015	-.631	-7.702	-1.349	1.477	-.383	-.404	-.034	-.173	.101	.177	-23361.
43	-.013	.005	.139	-67.881	3.729	9.470	1.385	-.117	.000	-.189	.110	.214	-137316.
44	-.033	-.036	.054	.000	-.348	-.847	-1.819	-.827	-.104	-.220	-.082	-.050	-11451.
45	.004	.022	-.016	-.007	-.120	-.105	-.283	-.010	.000	-.176	.036	.113	-1451.
46	-.008	.004	-6.510	-4.348	.434	1.770	-.068	-.048	-.027	-.116	-.007	.068	-23495.
47	-.014	-.009	.615	-31.905	.219	-3.252	-1.503	.000	-.134	-.221	-.080	.000	-94125.
48	-.069	-.002	-.015	-27.179	-39.011	2.822	-.800	-.063	.000	-.136	-.116	-.073	-171022.
49	-.027	-.002	.134	-12.172	.412	.837	-.146	-.160	-.055	-.236	-.078	-.037	-29891.
50	-.016	-.023	-.338	-9.702	-6.433	-.884	-.577	-.781	.000	-.155	-.061	.024	-49819.
51	-.059	-.097	-.002	-17.701	-30.028	5.962	-.066	-.054	-.046	-.579	-.145	-.044	-113738.
52	.000	-.047	.054	-10.748	.117	1.522	-.163	-.006	.000	-.166	-.041	.004	-24562.
53	-.035	-.031	-.675	-4.861	-2.003	-12.795	-20.432	-2.148	-.275	1.234	2.402	2.534	-97979.
54	-.081	-.227	-.679	-1.229	-1.252	-11.387	-5.992	.297	-.171	-.649	-.901	.206	-57857.
55	-.152	-.073	.154	-49.406	-20.892	-.907	7.638	12.811	.985	-.696	.269	.476	-129108.
56	.482	.445	-2.098	-39.906	-3.444	9.892	7.673	9.601	-.136	-.516	.150	-.086	-46359.
57	-.031	.011	-1.302	-4.225	.996	-.467	-.321	-.281	-.203	-.221	-.065	-.040	-16044.
58	-.029	-.005	-1.019	-6.024	.256	1.821	.000	.000	.000	.000	.000	.000	-13028.
59	-.002	-.015	-.906	-.294	.000	.000	-.024	.000	-.008	-.109	-.139	-.065	-4142.
60	-.061	-.042	1.117	-27.299	.508	4.133	.000	-.008	.000	-.181	.000	.000	-56465.
61	.000	-.006	-.028	.000	-.067	.000	.000	.000	.000	-.148	.000	.000	-665.
62	.000	-.032	.240	.123	-.167	-.047	.000	.000	.000	-.188	.000	.000	-188.
63	-.062	-.086	-.521	.359	-.197	.877	-.795	-.444	-.127	.211	.010	.542	-1829.
64	-.026	-.029	.010	-1.054	-1.076	.996	-.162	-.021	.000	-.198	.000	.000	-4166.
65	.012	-.002	.000	-.010	-7.041	-7.290	-1.522	-.127	.324	-.011	.283	.357	-39670.
66	-.023	.001	-5.000	-6.735	.510	1.851	.000	.000	.000	-.183	.000	.000	-25240.
67	.000	.000	1.159	-1.602	-4.457	1.385	.000	.000	.000	-.178	.000	.000	-9873.
68	.000	.001	-1.011	-.091	-.070	.556	.068	.209	-.001	-.126	.136	.150	-532.
69	-.015	.000	.000	-92.972	-5.956	13.463	10.305	1.387	.484	.077	.404	.495	-186930.
70	-.033	-.064	-.204	-7.262	-41.670	6.679	-2.255	-.346	-.167	-.497	.233	.603	-120421.
71	-.047	-.005	-.177	-16.240	-4.030	1.807	-5.480	.679	.902	-.074	-.058	.419	-58564.
72	.000	.000	-19.284	-10.922	-.837	-3.003	-.927	-.226	-.064	-.179	-.028	.000	-93792.
73	.000	.000	-.309	.000	-.326	.129	-.021	.000	.000	-.107	-.036	-.020	-1856.
74	-.005	-.024	.507	-68.541	-30.473	12.147	10.590	-.019	-.037	-.193	-.020	-.034	-198948.
MAX	.482	.445	1.159	.359	3.920	13.463	10.590	12.811	.985	1.234	2.402	2.534	519.
MIN	-.152	-.227	-19.284	-92.972	-41.670	-12.795	-20.432	-2.148	-.387	-.696	-.901	-.109	-198948.
MEAN	-.011	-.011	-.802	-11.501	-4.488	.542	-.796	.278	.012	-.160	.028	.105	-42914.

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TABLE: 5.4 Sherwood Flow Difference (E55A-J55A)

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

5.3.2.1 Filling of Rafferty and Alameda Reservoirs

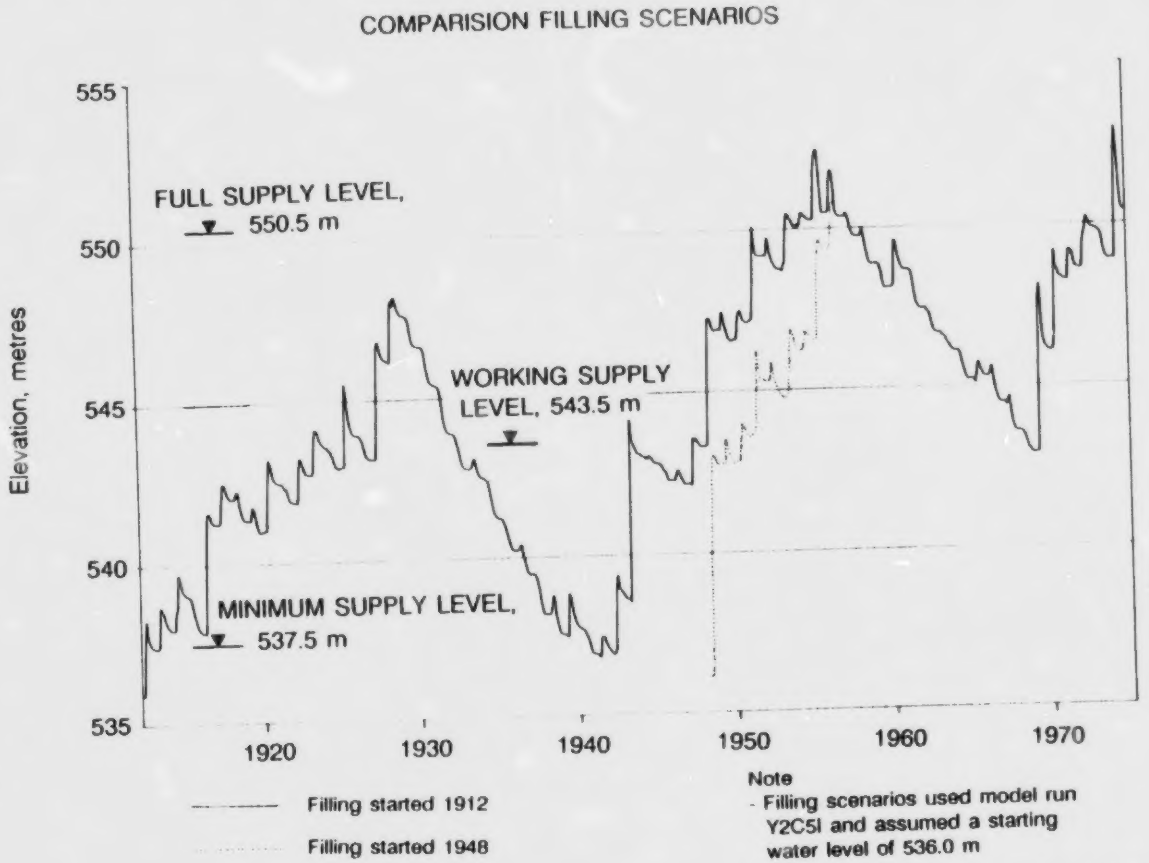
Reservoir filling probabilities were determined for the SBDA EIS. In order to demonstrate the filling possibilities, two runs were selected from Saskatchewan's earlier simulations (Figures 5.9 and 5.10). Both simulations were for 50/50 delivery at Sherwood with 4800 ha of irrigation, for study periods of 1912 to 1974 and 1948 to 1974. Both simulations supported all the proposed uses including the international apportionment obligation during the filling periods. No additional water was retained by Saskatchewan above the apportionment levels of 50/50 delivery. The 1912 to 1974 period included the dry 1930s while the 1948 to 1974 period was very wet. In fact, 1948, 1955, 1956 and 1974 were the wettest years in the record. It is interesting to note that in the two simulations both the Rafferty and Alameda reservoirs filled in 1955. The 1912 run took 43 years to fill the reservoirs, while the 1948 run took seven years to fill the reservoirs. Boundary Reservoir during this period frequently remained near FSL after spring runoff, except during the 1930s. The filling period may possibly lie between these two examples.

The amount of water passed to North Dakota during the simulation with the filling period beginning in 1912 (C51A12) was compared to the simulation beginning with the reservoirs near FSL (C51A) in 1912. Table 5.5 shows the monthly and annual differences in these two arrays. The large difference between the two simulations in 1928 is a result of model instability and should be disregarded.

Another way of considering filling of Rafferty Reservoir is to note that the volume of inflow from a 1:100 flood is approximately 370 000 dam^3 while Rafferty has a capacity at FSL of 443 000 dam^3. If the 1:100 flood occurred when the reservoir was empty the reservoir would be 83 percent full if the entire flow was stored.

5.3.2.2 Ground Water

Preliminary calculations of Rafferty Reservoir recharge of ground water in the Estevan Valley Aquifer are very crude because there is a lack of data concerning the overall vertical permeability of confining sediments overlaying the aquifer and the total extent of the intersecting area. However, it is estimated that Rafferty Reservoir will lose approximately 530 dam^3/year to the aquifer if the reservoir level is high.



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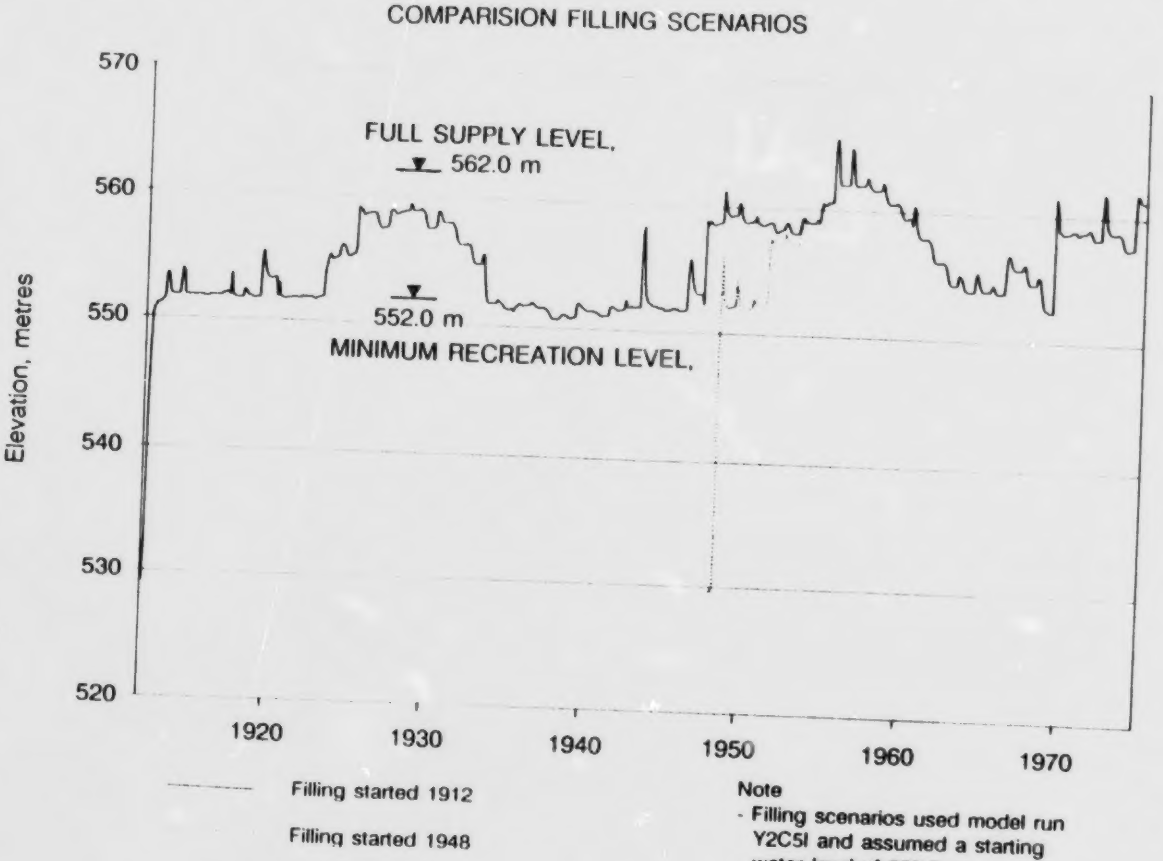
DATE: July, 1989

Rafferty - Alameda Project
Initial Environmental Evaluation

FIGURE: 5.9 Rafferty Reservoir, Filling Scenarios

SOURCE: Environment Canada Conservation and Protection



Note
- Filling scenarios used model run Y2C5I and assumed a starting water level of 529.0 m

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DATE: July, 1989

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Initial Environmental Evaluation

FIGURE: 5.10 Alameda Reservoir, Filling Scenarios

SOURCE: Environment Canada Conservation and Protection

SHERWOOD FLOW DIFFERENCE (C51A12 - C51A) Flow = m^3/sec, Total = dam^3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
12	-.004	-.001	-.492	-2.448	2.866	-.001	-.002	-.001	-.082	.001	-.151	-.124	-944.
13	-.001	.006	-.006	.004	.000	-.001	-.007	.001	.004	.000	.002	.000	3.
14	.002	-.001	.007	-.007	.001	.000	-.006	-.003	.000	-.006	.000	.015	6.
15	-.001	.001	-.002	.000	.002	.000	.000	.000	.000	.000	.000	.000	-0.
16	.000	.001	.000	.000	.002	.000	.001	.001	-.007	.007	.004	-.001	21.
17	.001	.001	.001	.000	.002	.001	.002	.001	.000	-.005	.000	.000	10.
18	.000	.000	.002	.000	.001	.001	-.001	.009	.000	-.015	.002	-.008	-24.
19	-.001	.002	.002	-.003	.018	-.016	.001	.001	.001	.001	.001	.000	20.
20	.001	-.011	.000	.000	.007	-.001	-.004	.004	.006	.000	-.007	-.002	-16.
21	.002	.001	-.002	.001	.012	-.012	.000	.000	.000	.000	.000	.000	6.
22	-.001	.000	-.001	-.002	.000	-.001	.001	.004	.000	.000	.000	.000	0.
23	-.001	-.001	.000	.000	-.001	.001	-.004	-.002	.000	.000	.014	.001	18.
24	-.001	.001	-.008	.007	-.002	.001	-.006	.000	-.006	-.006	.006	.000	-38.
25	-.001	.001	.008	.000	-.006	.000	-.001	.001	.000	.000	.000	.000	5.
26	.000	.000	-.002	-.004	.000	.006	-.008	.012	.000	-.011	.016	-.008	1.
27	-.001	-.002	.000	.000	.007	.000	.001	.004	.000	.000	.000	.007	43.
28	.000	.000	.000	.000	-5.892	-9.273	-4.377	.179	.976	1.041	.911	.931	-40888.
29	.001	.000	-.004	-.004	.015	-.014	-.012	.010	.002	.000	-.003	.000	-22.
30	.000	-.002	-.003	.005	.000	.000	.000	.000	.000	.000	.000	.000	0.
31	.000	.000	-.001	.000	.010	.000	-.008	.007	.000	.000	.000	.000	21.
32	-.001	.000	.001	.001	.000	.002	-.003	.003	.000	-.001	-.001	-.001	-0.
33	-.001	-.001	.000	.000	.002	.001	-.007	.001	-.009	.001	-.002	-.012	-71.
34	-.010	-.002	.014	-.003	.006	.000	-.003	.004	.000	.000	.000	.000	17.
35	.000	.000	.002	.001	-.003	.000	.001	.001	.001	.001	.001	.001	16.
36	.000	-.002	.003	.001	.001	.001	.003	.005	-.010	.000	.006	.001	25.
37	-.003	.004	.000	.008	.002	-.003	-.005	.001	.001	.001	.002	.000	20.
38	.001	-.003	.000	-.009	.008	.000	-.010	.015	-.004	.000	.000	.000	-3.
39	.005	-.009	-.144	-.002	.009	.148	.002	.006	-.007	-.008	.000	.000	-10.
40	.002	-.002	.001	.001	.012	.002	-.009	.005	.005	-.003	.000	.000	37.
41	.004	-.001	-.047	-.305	.341	-.953	.033	.016	.000	.000	.000	-.061	-2497.
42	-.015	-.007	-.004	.027	.000	.000	-.009	.004	.002	.002	-.001	-.001	-6.
43	.002	.002	-.001	.000	.000	.000	.001	.004	-.005	-.003	.000	-.002	-5.
44	-.002	.000	.002	.006	.002	-.009	-.010	-.001	-.010	-.017	.003	.002	-90.
45	.001	.000	-.005	.006	.005	-.005	-.005	.005	-.002	-.001	-.001	-.001	-8.
46	-.004	.002	.002	.009	-.008	.000	-.007	.006	-.006	-.005	.007	.005	1.
47	-.004	.003	.002	.000	-.002	.000	-.001	-.001	-.002	-.011	-.002	.010	-22.
48	.002	.001	.003	.000	.006	-.007	-.009	.017	-.003	.000	.001	.003	38.
49	.000	.001	-.001	.000	.000	.000	-.005	.001	-.007	-.004	-.002	.004	-34.
50	-.002	.001	-.001	.002	.011	-.012	-.001	.009	-.011	-.005	.000	.006	-6.
51	.006	.005	-.005	.000	.000	-.005	-.001	-.001	.002	-.006	-.003	.009	2.
52	-.001	-.002	.000	.000	-.001	-.001	-.002	.011	-.004	-.008	-.005	.006	-17.
53	-.009	-.001	.010	.002	.001	-.002	-.430	-.004	.002	-.001	.302	.142	6.
54	.002	.002	-.004	-.002	.001	.002	-.165	.167	.001	.001	.001	.001	18.
55	-.002	.003	-.002	.000	.000	.000	.000	.000	.000	-.380	.000	.000	-1021.
56	-.002	.001	.001	.000	.000	.000	.000	.000	-.006	-.001	.003	-.001	-13.
57	-.008	-.008	.010	.003	-.002	.004	-.014	.000	-.003	-.002	.007	-.002	-39.
58	-.001	-.002	.000	.004	.000	.000	.000	.003	-.003	-.008	.000	.000	-18.
59	-.002	.008	-.004	-.001	.008	-.003	.004	.006	-.002	-.006	.003	-.008	6.
60	-.002	.007	-.004	.000	.000	.000	-.007	.001	.000	-.004	.000	.000	-26.
61	.000	-.002	.008	.001	.000	.000	.000	.006	.002	.000	.000	.000	40.
62	.000	-.005	.001	.002	.015	-.007	-.007	.004	-.002	-.001	.000	.000	2.
63	-.002	-.004	.006	.001	.004	-.006	-.008	.004	-.003	-.009	.010	.005	-4.
64	.008	.008	-.014	-.004	-.001	-.001	-.004	.007	.000	-.009	.000	.000	-28.
65	-.001	.000	.000	-.002	.000	.000	.001	.001	.001	.001	.001	.001	8.
66	.000	.004	-.001	-.003	.000	.000	-.010	.000	-.003	.000	.000	.000	-35.
67	.000	.000	-.001	.002	-.003	.000	.000	.004	-.002	.000	.000	.000	0.
68	-.001	.000	-.007	-.001	.005	.001	.001	.001	-.003	.000	.007	.001	10.
69	-.002	.001	.000	-.007	.000	.000	.000	.008	.000	.000	.000	.000	0.
70	-.001	-.002	.004	-.002	.000	.000	-.006	.000	-.002	.000	-.001	-.001	-29.
71	.000	.003	-.002	-.002	.000	.000	.000	.000	.000	.000	-.001	.002	-1.
72	.001	.001	-.002	-.004	.006	.000	.002	.001	-.009	-.013	.005	.000	-32.
73	.008	.005	.001	-.006	-.002	.001	-.012	.004	-.007	-.011	.000	.000	-51.
74	-.002	.002	.002	.000	.007	.000	.000	.000	.125	.005	.000	-.009	337.

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Initial Environmental Evaluation

TABLE: 5.5 Sherwood Flow Difference (C51A12-C51A)

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

5.3.3 North Dakota

Using the draft operating plan, the U.S. Army Corps of Engineers analyzed stream flows and water levels with the Project in place to determine optimimum benefits for flood control and waterfowl refuge production. The routed stream flows at Westhope were provided to Manitoba. Monthly data for the period 1912 to 1974 were analyzed to determine the impacts of lower flows on the refuges, the Eaton Irrigation District, Minot, and community water supply under the 50/50 and 60/40 delivery options. There will be little difference in delivery between the two options at either Sherwood or Westhope.

The elevation of Lake Darling determines the selection of the 50/50 or the 60/40 delivery option. When Lake Darling is below 485.24 m on October 1, the 50/50 apportionment rule applies; when Lake Darling is above 485.24 m on October 1, Saskatchewan may retain 60 percent of the natural flow of the Souris if the flow accumulated to September 30 is more than 24 700 dam^3.

Water stored in Lake Darling can be used to augment flows in the downstream refuges during low flow periods. The Project would be operated to ensure that North Dakota would receive its entitlement to water even during low flow periods.

During moderate and high runoff years, Saskatchewan would be allowed to take an additional 10 percent of the runoff, which would be taken from the surplus flows occurring during spring runoff. The retention of additional water during the spring runoff in the "wetter" years is not expected to have any significant effect on the quantity of water entering North Dakota. This eventuality was not simulated.

The flood operation plan with Rafferty and Alameda dams in place has the effect of lowering flood peaks and prolonging the duration of post-flood flows. Mean monthly flows for simulated historic (J55A) and the Project (E55A) conditions for the Souris River near Sherwood are provided in Tables 5.2 and 5.3 respectively. The monthly differences between the Project and simulated historic flows in Table 5.4 show that there would be 34 years during the period from 1912 to 1974 when the Project extends the duration of post-flood flow during the months of May to September. Increased flows would also result for 33 from November to February from 1912 to 1974. The general impact at Lake Darling would include a pre-flood drawdown and a delay in refilling, both dependent of the size of the flood. Primary hydrologic changes during flood periods would be due to floodwater release under the operating plan rather than the volume of water retained in Canada. The proposed project calls for controlled release of all flood events up to the 1:100 flood. Water would be stored in Canada and released according to the flood operation plan. The Project would result in higher than normal flows in the Souris River in the summer and fall as the stored flood flows were released.

The flood control and storage provided by the Project would substantially decrease the overall frequency of flooding compared to existing conditions. Sites located above the elevations reached by flows of 113 m^3/s at Sherwood would no longer be inundated. At flows below 57 m^3/s at Sherwood, the river would remain basically within the channel, and no flooding would occur.

Under Project flood operation conditions, flow volumes into Lake Darling would be reduced, and the degree of fluctuation in lake levels for all flood events would be less than at present. The potential for erosion at levels located above the 113 m^3/s floodplain would be greatly decreased as flows would no longer reach this level under controlled conditions.

Flow duration comparisons are very dependent on the period of record used, so it was necessary to compile data for the whole basin for a common period of time. The longest common period available was 1931 to 1974. To simplify the analysis and make it easier to comprehend, it was decided to compare three data sets. The first set is the existing data as recorded by Water Survey of Canada. The second set was the simulated historic data. The third set is simulated data modelled with the WRMM model for the Project. The 50/50 operating scenario was selected as the most appropriate because during periods of low flow the evaporation-sharing agreement would not apply and only 50 percent of the natural flow would be passed to the United States. Monthly data were used in the analysis because daily water use data cannot be simulated accurately.

The data in Table 5.6 indicate that the mean monthly flow at Sherwood under recorded conditions would have been greater than zero 88 percent of the time. With the Project in place, mean monthly flows would have been greater than zero 90 percent of the time. Flows would be greater than 1.0 m^3/s in excess of 25 percent of the time for all three data sets. This indicates that periods of zero flow would be less frequent than in the past and periods of low flow would occur with about the same frequency. The size of these flows can be put into perspective by comparison with the channel capacity which is 90 m^3/s upstream of Sherwood and 60 m^3/s downstream.

Table 5.6 Annual Low Flow Duration - Souris River at Sherwood (1931-1974)

	Percent of Time Mean Monthly Flow is Greater Than Given Values	
	0 m^3/s	1.0 m^3/s
Actual Recorded	88	28
Historic Simulated (J55A)	87	25
Project (E55A)	90	25

The flow-duration curve (Figure 5.11) for Sherwood shows that there is virtually no difference in the occurrence of flows below 14 m^3/s for all three data sets. During low flow years, the flow in the Souris River has historically been zero for periods of up to six months. The most severe period of low flow at Sherwood occurred from mid-December 1987 to mid-March 1989 when the flow was effectively zero. This was only broken during the March 21, 1988 to June 9, 1988 period when 448 dam^3 flowed across the boundary.

5.3.4 **Manitoba**

As mentioned above, the U.S. Army Corps of Engineers analyzed stream flows and water levels with the Project in place to determine optimum benefits for flood control and waterfowl refuge production. The routed stream flows at Westhope were provided to Manitoba for 1969 and 1975 (Figures 5.12 and 5.13). The difference in delivery between the 50/50 (C51A) and 60/40 options is 238 dam^3 as shown in Table 5.7. The 60/40 option would reduce flow to Manitoba by 0.1 percent. The average flows for the Souris River near Westhope under simulated historic and Project conditions are displayed in Figure 5.14.

The operation of the three reservoirs in Saskatchewan and regulation in North Dakota would result in less water being delivered to Manitoba. As shown in Table 5.7 for 1912 to 1974 the Souris River flows near Westhope under Project conditions would be 146 567 dam^3 while under simulated historic conditions flows would be 184 098 dam^3. The Project would reduce flows reaching Manitoba by 20 percent. After completion of the Project, the United States would deliver to the Manitoba boundary only sufficient water to meet the requirements of the Interim Measures. The frequency and duration of this minimum flow delivery would probably increase over pre-Project conditions as demonstrated by an analysis conducted by Manitoba.

Mean monthly stream flows for simulated historic (J55A) and the Project (E55A) conditions for the Souris River near Westhope are provided in Tables 5.8 and 5.9, respectively. The monthly differences between the Project and simulated historic flow shown in Table 5.10 indicate that in eight years there would be an increase in flow after the flood peak during the period from 1912 to 1974. There would be three years when there would be increased flow during the period from November to February.

The critical period for Manitoba would be during low flow years when lower than historical flows would be delivered but flow rates would still be in compliance with the Measures. Under Project (E55A) conditions, the simulation runs indicate that North Dakota would have been able to meet the Interim Measures even during the major drought of the mid-1930s, but there would not have been any flow in the winter months. Historical flow records indicate that the Souris River had flow only in the months of April, June and July in 1937.

Project simulation runs of mean monthly flows at Westhope indicate that stream flows would be maintained at 0.566 m^3/s or greater from June through October for the entire period from 1912 to 1974. Zero flows would occur in some other months (November to May) for both simulations (E55A and J55A). It should be noted that whether these simulations assumed that initial reservoir levels were nearly full in Saskatchewan or the reservoirs were beginning to fill the stream flows entering North Dakota would be in accordance to its entitlement.

Unfortunately the computer model was unable to simulate the severe drought criteria. Manitoba did additional analysis on the data provided by Sask Water on May 14, 1989. The Project (E55A) and simulated historic (J55A) were analyzed in accordance with the severe drought criteria defined by International Souris River Board of Control. Severe drought is defined as a period when the combined storage in Lake Darling and in the five lower refuges drops below 66 600 dam^3(54 000 acre-feet). The severe drought condition continues until the combined storage exceeds 70 300 dam^3 (57 000 acre-feet). To simulate this, Manitoba used an adjustment routine using a storage of 49 300 dam^3 (40 000 acre-feet) on Lake Darling as a proxy for the 66 600 dam^3 (54 000 acre-feet) trigger. When the storage on Lake Darling dropped below this value, the routine reduced the flow at Westhope to 10 cfs and added that volume to Lake Darling. Once levels recovered on Lake Darling the total "hold back" volume that was applied to Lake Darling was then transferred to April to October Westhope flows at a rate of one-fourteenth of the volume each month. Manitoba determined that under simulated historic conditions (J55A) that drought criteria 0.283 m^3/s (10 cfs) would have been applied in five years: 1932, 1935, 1937, 1938 and 1961, while under Project conditions (E55A) the drought criteria would have been applied in seven years: 1931, 1932, 1934, 1935, 1937, 1938 and 1961. (Manitoba, 1989).

Using the 1912 and 1948 filling simulations, stream flows at Westhope would be essentially the same as those simulated with high initial reservoir levels because, in all cases, obligations to the United States would have been met.

Under recorded conditions, flows at Westhope were greater than zero 87 percent of the time while under simulated historic conditions flows were greater than zero 89 percent of the time (Table 5.11, Figure 5.15). Under the Project (E55A) flows would be greater than zero 88 percent of the time. A similar pattern would occur with flows of 0.566 m^3/s (20 cfs) exceeded 52 percent of the time for the record flow, 55 percent of the time for simulated histroic and 53 percent of the time under the Project operation.

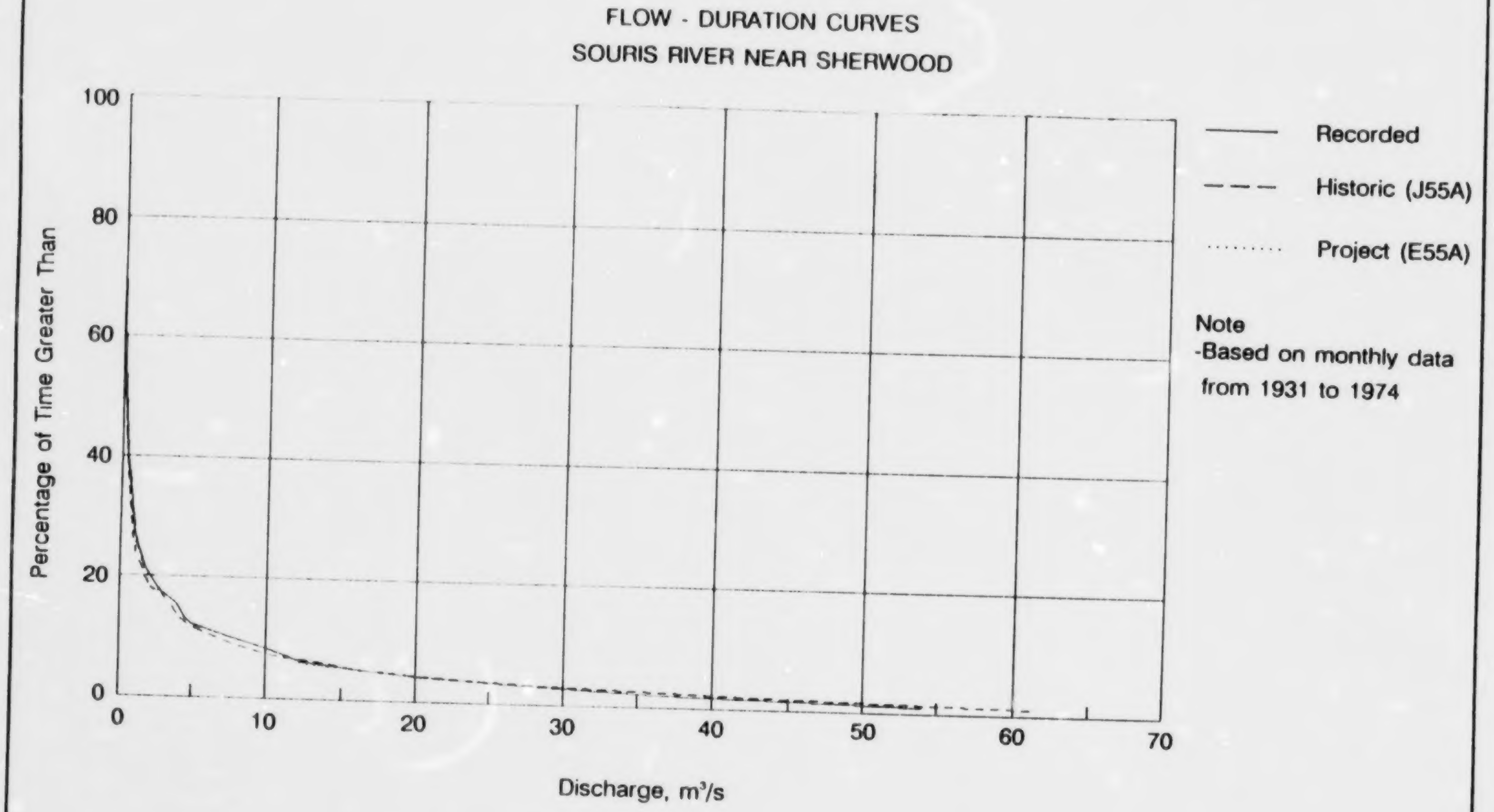

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FIGURE: 5.11 Flow Duration Curve, Sherwood

SOURCE: Environment Canada Conservation and Protection

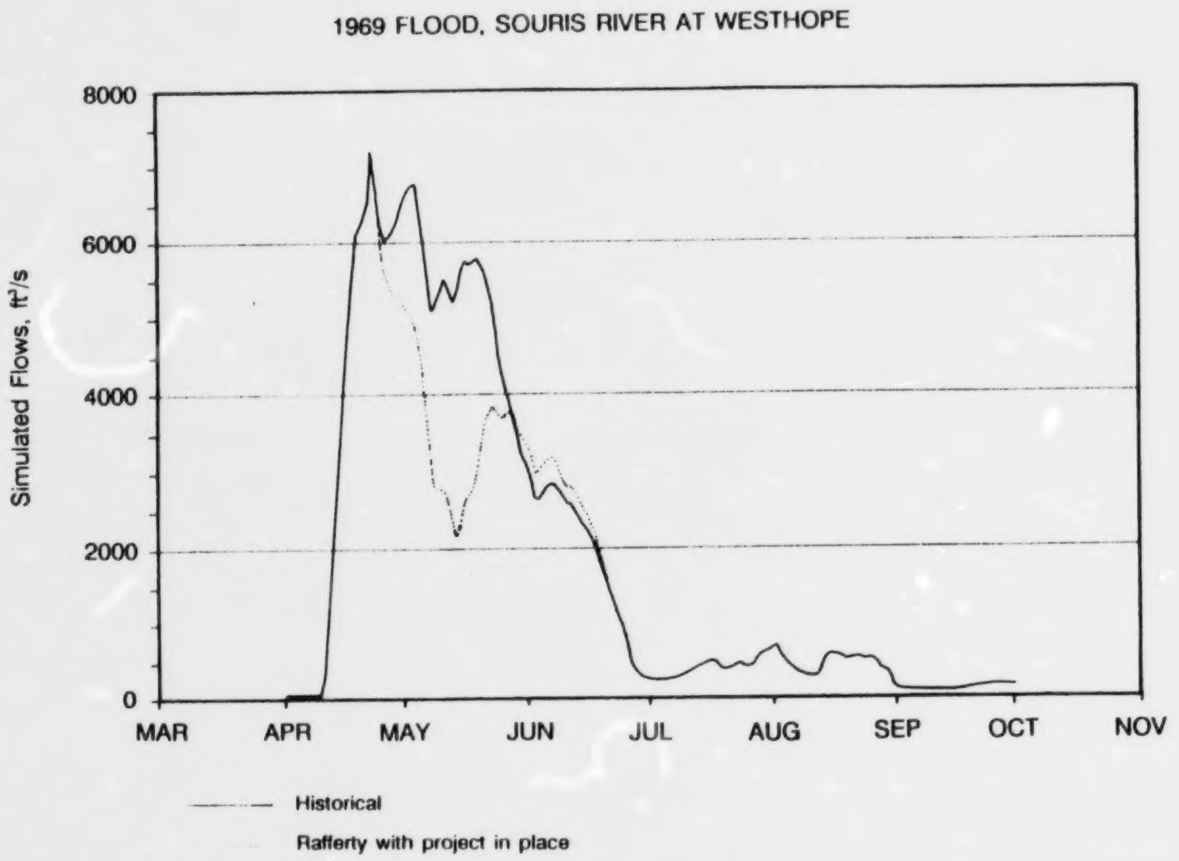

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FIGURE: 5.12 Souris River at Westhope, 1969 Flood

DATE: July, 1989

SOURCE: Manitoba - Implications Report

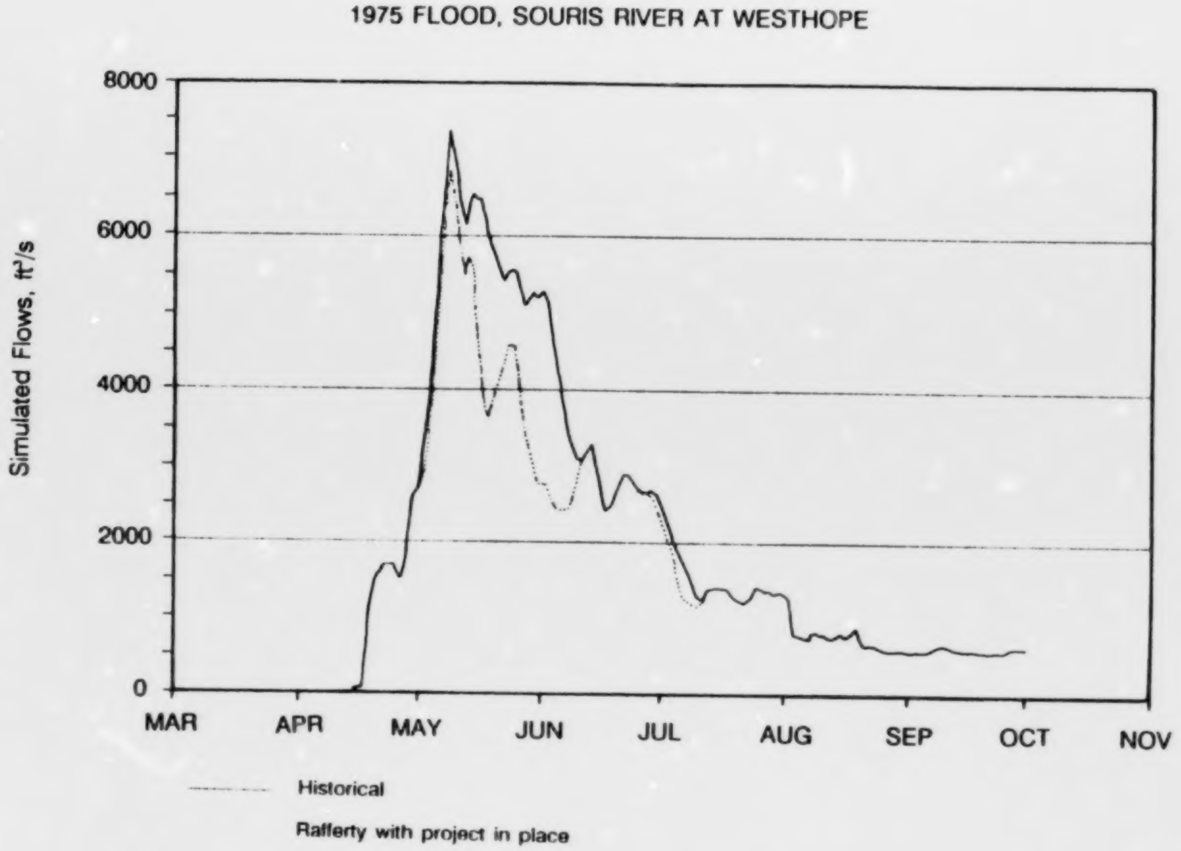

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		FIGURE: 5.13 Souris River at Westhope, 1975 Flood
DATE: July, 1989		**SOURCE:** Manitoba - Implications Report

MEAN FLOWS FOR WESTHOPE (#507)

	JAN (cu.m/s)	FEB (cu.m/s)	MAR (cu.m/s)	APR (cu.m/s)	MAY (cu.m/s)	JUN (cu.m/s)	JUL (cu.m/s)	AUG (cu.m/s)	SEP (cu.m/s)	OCT (cu.m/s)	NOV (cu.m/s)	DEC (cu.m/s)	TOTAL (cu.dams)
1912-1974													
J55A	.447	.586	3.054	13.870	17.465	10.402	9.413	4.458	2.537	4.684	1.625	1.127	184098
E55A	.447	.594	2.482	7.282	11.333	9.759	9.413	4.713	2.531	4.271	1.556	1.080	146567
C41A	2.487	.257	1.731	7.960	12.043	9.978	10.652	5.062	3.377	5.713	4.238	.927	170275
C51A	2.489	.276	1.768	8.157	12.204	10.133	10.534	4.787	3.255	5.740	4.175	.929	170321
1931-1974													
J55A	.490	.618	3.533	18.672	19.765	11.060	10.220	4.807	2.504	4.582	1.880	1.158	208726
E55A	.461	.636	2.729	10.260	13.755	10.774	10.233	5.172	2.496	4.419	1.838	1.161	168886
C41A	2.438	.311	2.098	11.032	14.221	10.950	11.388	5.704	3.566	6.066	4.548	.999	193705
C51A	2.440	.335	2.134	11.286	14.237	11.043	11.559	5.441	3.391	6.086	4.461	1.003	193943
Recorded	.602	.588	1.083	17.763	22.344	14.175	7.607	3.228	1.607	1.464	1.120	.718	190500
1959-1974													
J55A	.560	.657	4.639	23.918	28.214	10.705	10.991	4.124	3.257	5.985	2.849	1.726	257790
E55A	.526	.688	2.754	13.377	20.520	11.594	12.295	4.124	3.235	5.881	2.849	1.656	210066
C41A	2.991	.263	1.682	14.458	21.623	11.766	13.166	4.799	4.645	7.499	6.153	1.612	239551
C51A	2.991	.264	1.764	14.689	21.053	12.089	13.875	4.830	4.163	7.654	6.152	1.613	240827
Recorded	.561	.603	1.247	20.729	29.592	18.588	6.969	3.107	1.831	1.784	1.408	.588	229206

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TABLE: 5.7 Mean Flows for Westhope

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

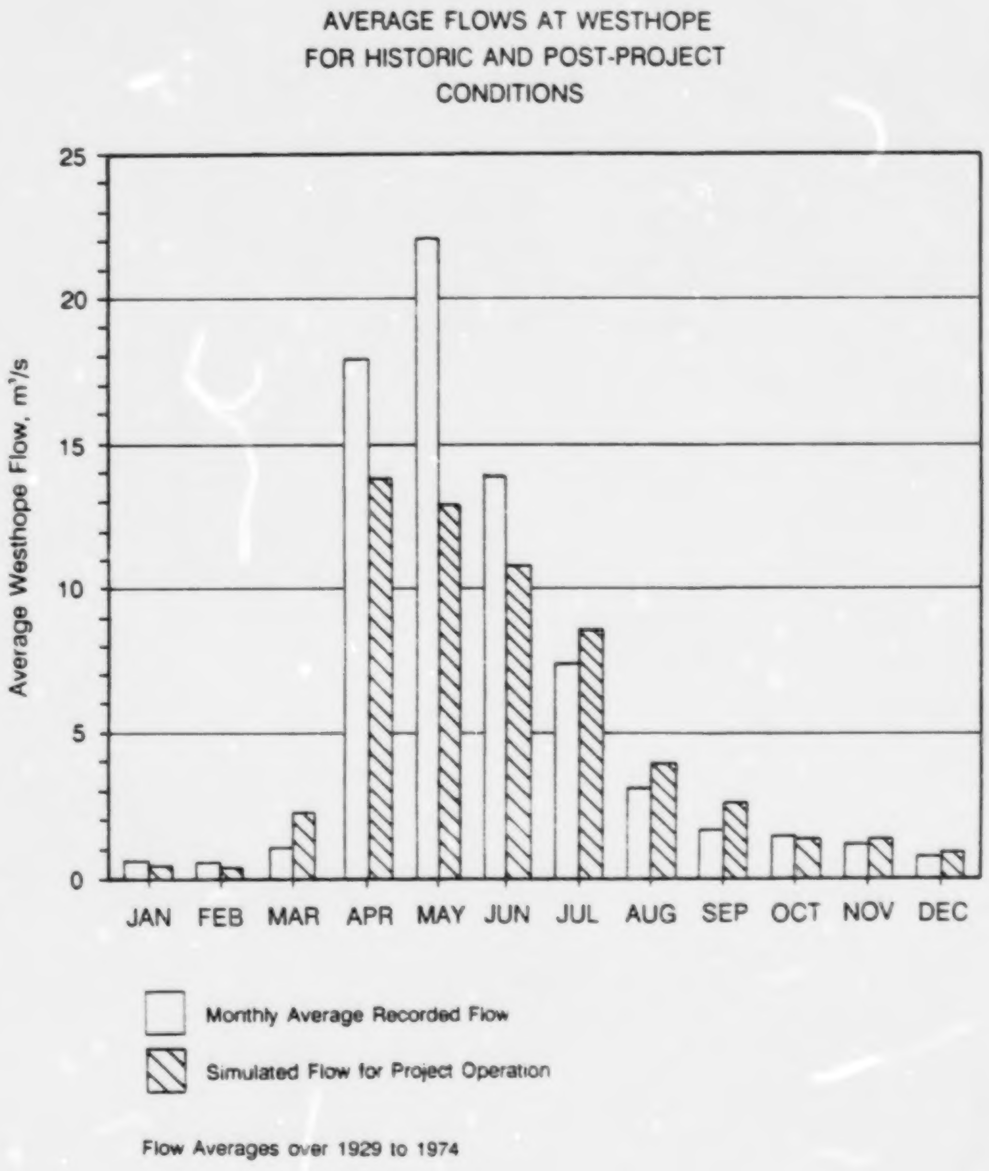

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FIGURE: 5.14 Average Flows at Westhope

DATE: July, 1989

SOURCE: After Manitoba - Implications Report

WESTHOPE FLOW SIMULATED HISTORIC (J55A) Flow = m³/sec. Total = dam³

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
12	.235	.350	2.277	4.686	24.315	5.633	10.048	3.369	2.015	6.361	1.593	1.939	166966.
13	.076	.356	2.575	3.811	9.015	1.768	.566	.566	.566	5.373	.040	.408	66655.
14	.700	.198	.000	.020	4.030	1.544	.723	.730	2.411	5.368	.216	.402	43357.
15	.078	.058	.947	.020	.018	.566	.566	.566	.566	.566	.083	.000	10683.
16	.000	.000	.000	.020	31.943	27.121	25.878	2.715	1.790	5.926	.171	1.080	256337.
17	.128	.144	1.432	.020	5.033	3.154	.793	.566	.566	5.056	.000	.445	46075.
18	.295	.123	.000	.020	.018	.566	.566	.566	.566	.566	.000	.000	8670.
19	.000	.000	.731	.020	12.078	.566	.566	.566	.566	.566	.000	.000	41842.
20	.000	.000	.142	.020	5.838	13.040	8.867	.566	.642	5.606	.654	.232	94129.
21	.277	.406	2.212	.020	.018	2.838	.566	.566	.866	3.946	.684	.554	34207.
22	.479	.635	.394	.020	14.897	2.061	1.487	.566	.566	3.408	.814	1.022	70110.
23	.929	.602	3.371	.020	34.304	23.661	22.862	10.705	9.112	7.929	1.513	1.112	307896.
24	.751	.720	1.746	1.028	.571	.812	.566	.566	.566	6.247	.605	1.790	42322.
25	1.370	.989	1.459	16.168	17.039	14.311	9.184	.566	.566	6.729	1.102	1.482	187039.
26	.871	1.066	2.947	.020	.018	.566	.566	.566	.566	1.690	1.616	1.581	31821.
27	.568	.950	2.611	.020	49.778	52.443	56.174	24.681	9.150	12.953	6.648	4.933	585539.
28	.574	.651	6.004	23.878	18.564	16.912	10.974	19.793	17.445	10.577	3.063	1.675	343022.
29	.663	.719	3.431	.020	.018	.566	.566	.566	.566	3.719	.887	.879	33385.
30	.495	1.775	4.678	2.422	3.124	.566	.579	.566	.566	.894	.587	.540	44158.
31	.125	.088	.512	.020	.018	.566	.566	.566	.566	.566	.000	.000	9501.
32	.022	.042	.000	.020	.018	.566	.566	.566	.566	.566	.000	.000	7743.
33	.005	.000	.000	4.559	.018	.566	.566	2.353	.594	.566	.000	.070	24407.
34	.017	.000	.000	.020	.018	.566	.566	.566	.566	.566	.000	.000	7628.
35	.000	.017	.515	.020	.018	.566	.566	1.959	.810	.566	.000	.000	13366.
36	.000	.017	.608	.020	.018	.566	.566	.566	.566	.566	.040	.000	9355.
37	.000	.000	.060	.020	.018	.566	.566	.566	.566	.566	.113	.000	8036.
38	.000	.000	.000	.020	.018	.566	.566	.566	.566	.566	.000	.000	7582.
39	.000	.000	.000	.020	.018	.566	.566	.566	.753	.566	.200	.000	8585.
40	.000	.000	.000	1.328	.351	.566	.566	.566	.566	.566	.000	.000	11864.
41	.000	.000	.320	.020	.018	.566	1.073	.566	.566	1.520	3.817	.000	22246.
42	.000	.000	4.248	.020	5.128	.566	.566	.566	.566	.746	.729	.512	36390.
43	.538	.631	9.438	15.952	50.884	26.980	21.659	13.909	1.387	7.540	1.673	.935	401710.
44	.028	.931	2.747	.020	2.758	20.899	9.545	31.369	8.178	12.961	2.262	.942	245176.
45	.323	.754	14.042	6.664	2.475	.566	.566	.997	1.243	5.377	1.547	.430	92640.
46	.308	.485	2.971	1.470	.606	.566	.566	.566	.566	1.428	.828	.581	28882.
47	.383	.000	3.796	15.575	22.920	15.762	3.305	6.445	.733	5.158	1.185	.600	200316.
48	.607	1.143	.416	30.903	69.568	42.317	43.191	2.733	2.845	6.640	3.305	1.163	541466.
49	.978	.000	3.349	100.975	19.160	12.335	14.084	1.556	.566	5.286	1.219	1.426	421101.
50	.707	.184	8.453	15.416	54.511	32.512	29.082	4.153	3.205	5.510	3.210	.698	417483.
51	1.064	1.525	1.244	77.236	59.565	34.769	32.535	3.580	.566	7.768	.613	.618	581974.
52	.803	3.573	1.578	25.230	8.195	.566	.566	.566	.566	6.313	1.559	.269	130003.
53	.484	.967	4.671	.020	9.348	30.443	20.892	29.004	23.576	7.451	1.840	4.176	350806.
54	1.486	2.334	6.405	2.274	1.046	39.808	32.627	34.195	5.109	7.894	8.894	3.875	385454.
55	2.828	1.662	8.638	82.356	56.037	32.478	29.239	4.771	.566	4.506	2.062	2.771	599865.
56	1.615	1.677	1.094	58.394	55.485	13.865	16.375	.566	.566	6.162	1.571	2.722	421928.
57	.173	.426	3.700	.267	.018	2.272	1.102	.566	.566	7.205	.000	1.127	46284.
58	.113	.212	2.442	.020	.018	2.446	2.452	.566	.566	.699	.455	.419	27521.
59	.000	.000	.000	.020	.018	.566	.566	.566	2.786	.566	1.195	1.042	19225.
60	.000	.000	.000	35.271	25.454	4.310	4.431	1.314	.566	4.606	.374	.391	201978.
61	.414	.999	1.500	.020	.018	.566	.566	.566	.566	.566	.648	.000	16805
62	.000	.023	.000	.020	.018	.566	.597	1.396	.566	.911	.721	.000	12737.
63	.000	.000	1.053	.020	.018	.566	3.700	1.224	.566	6.277	1.904	1.453	44682.
64	.269	.355	4.570	.020	1.246	6.486	5.284	.985	3.415	3.518	2.904	.992	79270.
65	.591	.140	2.539	.020	8.206	2.457	10.827	4.081	8.250	12.548	7.005	1.468	154132.
66	.489	.272	12.199	8.121	8.007	1.928	1.411	.566	.566	5.290	3.549	.150	112666.
67	1.161	1.265	7.734	3.656	5.313	.566	.566	.566	.566	.566	.000	.000	58073.
68	.000	.000	.437	1.107	.589	.566	.566	.566	4.497	4.114	2.265	2.272	44748.
69	1.757	1.228	2.518	125.763	102.417	30.550	29.989	4.208	8.596	4.837	.172	1.312	824687.
70	.888	.312	4.774	21.737	94.945	49.769	52.410	19.495	8.586	7.288	2.144	3.132	703876.
71	.765	1.775	3.627	22.337	23.114	9.855	1.448	.566	8.407	12.674	7.804	4.515	254860.
72	1.552	2.013	29.037	70.971	39.952	15.779	14.373	12.478	2.089	12.483	6.534	5.379	560773.
73	.000	1.091	3.948	.020	1.414	.566	.566	4.086	.917	13.255	6.415	1.650	89906.
74	1.069	1.037	.288	93.586	140.696	46.178	48.562	13.327	1.176	6.267	1.943	3.859	946221.
MAX	2.828	3.573	29.037	125.763	140.696	52.443	56.174	34.195	23.576	13.255	8.894	5.379	946221.
MIN	.000	.000	.000	.020	.018	.566	.566	.566	.566	.566	.000	.000	7582.
MEAN	.477	.586	3.054	13.870	17.465	10.402	9.413	4.458	2.537	4.684	1.635	1.127	184098.

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TABLE: 5.8 Westhope Flow Simulated Historic (J55A)

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

WESTHOPE FLOW PROJECT (E55A) Flow = m^3/sec, Total = dam^3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
12	.235	.350	2.277	4.413	11.439	4.531	10.048	3.369	2.015	6.361	1.593	1.939	128915.
13	.076	.356	2.056	.020	8.918	1.232	.566	.566	.566	5.373	.040	.408	53789.
14	.700	.198	.000	.020	4.030	1.544	.723	.730	2.411	2.539	.216	.402	35780.
15	.078	.058	.947	.020	.018	.566	.566	.566	.566	.566	.083	.000	10683.
16	.000	.000	.000	.020	12.878	25.021	25.878	2.715	1.790	5.926	.171	1.080	199830.
17	.128	.144	1.432	.020	.018	3.154	.793	.566	.566	.566	.000	.336	20325.
18	.295	.123	.000	.020	.018	.566	.566	.566	.566	.566	.000	.000	8670.
19	.000	.000	.731	.020	4.654	.566	.566	.566	.566	.566	.000	.000	21957.
20	.000	.000	.142	.020	.018	9.230	8.867	.566	.642	2.244	.654	.232	59661.
21	.277	.406	2.212	.020	.018	.633	.566	.566	.866	3.946	.684	.554	28492.
22	.479	.635	.394	.020	13.844	.566	.566	.566	.566	.566	.000	.519	49878.
23	.929	.602	3.371	.020	25.004	17.980	20.458	10.705	9.112	7.929	1.513	1.112	261823.
24	.751	.720	1.746	.150	.571	.566	.566	.566	.566	3.995	.605	1.790	33377.
25	1.370	.989	1.459	.020	2.808	11.885	9.184	.566	.566	6.729	1.102	1.482	100779.
26	.871	1.066	2.947	.020	.018	.566	.566	.566	.566	1.121	.000	.004	21884.
27	.091	.639	2.611	.020	2.140	40.451	54.346	24.681	9.150	12.953	6.418	4.404	617923.
28	.459	.651	5.867	.020	19.239	20.566	6.794	19.793	17.445	10.577	3.063	1.675	280590.
29	.663	.719	3.431	.020	.018	.566	.566	.566	.566	1.528	.887	.879	27517.
30	.495	1.775	4.678	2.422	3.124	.566	.579	.566	.566	.566	.087	.124	40869.
31	.000	.028	.189	.020	.018	.566	.566	.566	.566	.566	.000	.000	8156.
32	.022	.042	.000	.020	.018	.566	.566	.566	.566	.566	.000	.000	7743.
33	.005	.000	.000	4.559	.018	.566	.566	2.353	.594	.566	.000	.070	24407.
34	.017	.000	.000	.020	.018	.566	.566	.566	.566	.566	.000	.000	7628.
35	.000	.017	.515	.020	.018	.566	.566	1.959	.810	.566	.000	.000	13366.
36	.000	.017	.608	.020	.018	.566	.566	.566	.566	.566	.040	.000	9355.
37	.000	.000	.060	.020	.018	.566	.566	.566	.566	.566	.113	.000	8036.
38	.000	.000	.000	.020	.018	.566	.566	.566	.566	.566	.000	.000	7582.
39	.000	.000	.000	.020	.018	.566	.566	.566	.753	.566	.200	.000	8585.
40	.000	.000	.000	1.328	.351	.566	.566	.566	.566	.566	.000	.000	11864.
41	.000	.000	.320	.020	.018	.566	1.073	.566	.566	1.520	3.817	.000	22246.
42	.000	.000	4.248	.020	4.587	.566	.566	.566	.566	.566	.133	.000	31542.
43	.000	.000	6.475	.020	26.931	23.111	21.659	13.909	1.387	7.540	1.673	.935	275327.
44	.028	.931	2.747	.020	2.758	20.899	9.545	31.369	8.178	12.961	2.262	.942	245176.
45	.323	.754	14.042	6.664	2.475	.566	.566	.997	1.243	.945	1.547	.430	80769.
46	.308	.485	2.971	1.470	.606	.566	.566	.566	.566	.566	.024	.000	22933.
47	.000	.000	2.835	.020	13.408	6.736	2.506	6.445	.733	5.158	1.185	.600	105385.
48	.607	1.143	.416	4.473	23.946	45.138	42.391	2.733	2.845	6.640	3.305	1.163	355934.
49	.978	.000	3.349	88.470	19.433	12.589	14.084	1.556	.566	5.286	1.219	1.426	390078.
50	.707	.184	8.453	5.653	47.759	31.628	29.082	4.153	3.205	5.510	3.210	.698	371801.
51	1.064	1.525	.578	58.461	29.537	40.732	32.535	3.580	.566	7.768	.613	.618	466555.
52	.803	3.573	1.578	13.544	8.195	.566	.566	.566	.566	6.313	1.559	.269	99713.
53	.484	.967	4.671	.020	9.348	11.151	.566	27.973	23.576	7.451	2.631	7.265	253922.
54	1.708	2.710	5.726	1.044	.165	28.038	27.696	34.195	5.109	7.894	7.694	3.139	330795.
55	2.355	1.590	8.791	32.949	35.145	31.571	36.877	15.970	.566	4.506	2.062	2.771	462916.
56	2.171	2.351	1.316	18.488	52.041	23.757	24.048	6.459	.566	6.162	1.571	2.722	374957.
57	.173	.426	3.700	.020	.018	2.272	1.102	.566	.566	7.205	.000	1.127	45644.
58	.113	.212	2.442	.020	.018	2.446	2.452	.566	.566	.699	.455	.419	27521.
59	.000	.000	.000	.020	.018	.566	.566	.566	2.786	.566	1.195	1.042	19225.
60	.000	.000	.000	16.008	22.756	4.310	4.431	1.314	.566	3.693	.374	.391	142376.
61	.414	.999	1.500	.020	.018	.566	.566	.566	.566	.566	.648	.000	16805.
62	.000	.023	.000	.020	.018	.566	.597	1.396	.566	.911	.721	.000	12737.
63	.000	.000	1.053	.020	.018	.566	3.237	1.224	.566	6.277	1.904	1.453	43442.
64	.269	.355	4.570	.020	1.246	6.014	5.284	.985	3.415	3.518	2.904	.992	78046.
65	.591	.140	2.539	.020	8.206	.848	10.827	4.081	8.250	12.548	7.005	1.468	149962.
66	.489	.272	3.577	.020	8.007	1.928	1.411	.566	.566	5.290	3.549	.150	68575.
67	1.161	1.265	7.734	3.656	5.313	.566	.566	.566	.566	.566	.000	.000	58073.
68	.000	.000	.437	1.107	.589	.566	.566	.566	4.497	4.114	2.265	1.147	41735.
69	1.144	1.228	2.518	48.349	84.738	39.054	41.396	4.208	8.596	4.837	.172	1.312	627632.
70	.959	.813	5.854	15.309	53.275	56.448	50.156	19.495	8.586	7.288	2.144	3.132	591175.
71	.765	1.775	3.627	5.733	19.084	11.662	1.448	.566	8.407	12.674	7.804	4.515	205712.
72	1.552	2.013	6.734	60.049	39.115	12.777	14.373	12.478	2.089	12.483	6.534	5.379	462704.
73	.000	1.091	3.630	.020	1.414	.566	.566	4.086	.566	12.504	6.415	1.650	86133.
74	1.069	1.037	.288	63.663	84.498	48.493	60.730	13.327	1.176	6.267	1.943	3.859	756731.
MAX	2.355	3.573	14.042	88.470	84.738	56.448	60.730	34.195	23.576	12.961	7.804	7.265	756731.
MIN	.000	.000	.000	.020	.018	.566	.566	.566	.566	.566	.000	.000	7582.
MEAN	.447	.594	2.482	7.282	11.333	9.759	9.413	4.713	2.531	4.271	1.556	1.080	146567.

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TABLE: 5.9 Westhope Flow Project (E55A)

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

WESTHOPE FLOW DIFFERENCE (E55A - J55A) Flow = m^3/sec, Total = dam^3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
12	.000	.000	.000	-.273	-12.876	-1.102	.000	.000	.000	.000	.000	.000	-38051.
13	.000	.000	-.519	-3.791	-.097	-.536	.000	.000	.000	.000	.000	.000	-12865.
14	.000	.000	.000	.000	.000	.000	.000	.000	.000	-2.829	.000	.000	-7577.
15	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
16	.000	.000	.000	.000	-19.065	-2.100	.000	.000	.000	.000	.000	.000	-56507.
17	.000	.000	.000	.000	-5.015	.000	.000	.000	.000	-4.490	.000	-.109	-25750.
18	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
19	.000	.000	.000	.000	-7.424	.000	.000	.000	.000	.000	.000	.000	-19884.
20	.000	.000	.000	.000	-5.820	-3.810	.000	.000	.000	-3.362	.000	.000	-34469.
21	.000	.000	.000	.000	.000	-2.205	.000	.000	.000	.000	.000	.000	-5715.
22	.000	.000	.000	.000	-1.053	-1.495	-.921	.000	.000	-2.842	-.814	-.503	-20231.
23	.000	.000	.000	.000	-9.300	-5.681	-2.404	.000	.000	.000	.000	.000	-46073.
24	.000	.000	.000	-.878	.000	-.246	.000	.000	.000	-2.252	.000	.000	-8945.
25	.000	.000	.000	-16.148	-14.231	-2.426	.000	.000	.000	.000	.000	.000	-86260.
26	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.569	-1.616	-1.577	-9937.
27	-.477	-.311	.000	.000	-47.638	-11.992	-1.828	.000	.000	.000	-.230	-.529	-167616.
28	-.115	.000	-.137	-23.858	.675	3.654	-4.180	.000	.000	.000	.000	.000	-62432.
29	.000	.000	.000	.000	.000	.000	.000	.000	.000	-2.191	.000	.000	-5868.
30	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.328	-.500	-.416	-3289.
31	-.125	-.060	-.323	.000	.000	.000	.000	.000	.000	.000	.000	.000	-1345.
32	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
33	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
34	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
35	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
36	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
37	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
38	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
39	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
40	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
41	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
42	.000	.000	.000	.000	-.541	.000	.000	.000	.000	-.180	-.596	-.512	-4847.
43	-.538	-.631	-2.963	-15.932	-23.953	-3.869	.000	.000	.000	.000	.000	.000	-126384.
44	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
45	.000	.000	.000	.000	.000	.000	.000	.000	.000	-4.432	.000	.000	-11871.
46	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.862	-.804	-.581	-5949.
47	-.383	.000	-.961	-15.555	-9.512	-9.026	-.799	.000	.000	.000	.000	.000	-94931.
48	.000	.000	.000	-26.430	-45.622	2.821	-.800	.000	.000	.000	.000	.000	-185531.
49	.000	.000	.000	-12.505	.273	.254	.000	.000	.000	.000	.000	.000	-31023.
50	.000	.000	.000	-9.763	-6.752	-.884	.000	.000	.000	.000	.000	.000	-45682.
51	.000	.000	-.666	-18.775	-30.028	5.963	.000	.000	.000	.000	.000	.000	-115420.
52	.000	.000	.000	-11.686	.000	.000	.000	.000	.000	.000	.000	.000	-30290.
53	.000	.000	.000	.000	.000	-19.292	-20.326	-1.031	.000	.000	.791	3.089	-96884.
54	.222	.376	-.679	-1.230	-.881	-11.770	-4.931	.000	.000	.000	-1.200	-.736	-54659.
55	-.473	-.072	.153	-49.407	-20.892	-.907	7.638	11.199	.000	.000	.000	.000	-136949.
56	.556	.674	.222	-39.906	-3.444	9.892	7.673	5.893	.000	.000	.000	.000	-46971.
57	.000	.000	.000	-.247	.000	.000	.000	.000	.000	.000	.000	.000	-640.
58	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
59	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
60	.000	.000	.000	-19.263	-2.698	.000	.000	.000	.000	-.913	.000	.000	-59601.
61	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
62	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
63	.000	.000	.000	.000	.000	.000	-.463	.000	.000	.000	.000	.000	-1240.
64	.000	.000	.000	.000	.000	-.472	.000	.000	.000	.000	.000	.000	-1223.
65	.000	.000	.000	.000	.000	-1.609	.000	.000	.000	.000	.000	.000	-4171.
66	.000	.000	-8.622	-8.101	.000	.000	.000	.000	.000	.000	.000	.000	-44091.
67	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	0.
68	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	-1.125	-3013.
69	-.613	.000	.000	-77.414	-17.679	8.504	11.407	.000	.000	.000	.000	.000	-197056.
70	.071	.501	1.080	-6.428	-41.670	6.679	-2.254	.000	.000	.000	.000	.000	-112701.
71	.000	.000	.000	-16.604	-4.030	1.807	.000	.000	.000	.000	.000	.000	-49148.
72	.000	.000	-22.303	-10.922	-.837	-3.002	.000	.000	.000	.000	.000	.000	-98069.
73	.000	.000	-.318	.000	.000	.000	.000	.000	-.351	-.751	.000	.000	-3773.
74	.000	.000	.000	-29.923	-56.198	2.315	12.168	.000	.000	.000	.000	.000	-189490.
MAX	.556	.674	1.080	.000	.675	9.892	12.168	11.199	.000	.000	.791	3.089	0.
MIN	-.613	-.631	-22.303	-77.414	-56.198	-19.292	-20.326	-1.031	-.351	-4.490	-1.616	-1.577	-197056.
MEAN	-.030	.008	-.572	-6.588	-6.132	-.643	-.000	.255	-.006	-.413	-.079	-.048	-37530.

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Initial Environmental Evaluation

TABLE: 5.10 Westhope Flow Difference (E55A-J55A)

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

Table 5.11 Annual Low Flow Duration - Souris River at Westhope (1931-1974)

	Percent of Time Mean Monthly Flow is Greater Than Given Values			
	0 m^3/s	0.566 m^3/s	1.0 m^3/s	% of Time > 17 m^3/s
Actual Recorded	87	52	41	10
Simulated Historic (J55A)	89	55	46	10
Project (E55A)	88	53	45	9

Manitoba estimated agricultural and urban damages for the Project-modified floods for 1969, 1974, 1975, 1976 and 1974 (Table 5.12). These damages would have resulted from the controlled release of post-flood peak flows by the Project. The net benefit from reduced flood damages in Manitoba was $453,667 or $8724 per year for the period 1936 to 1987. The increase in damage, neglecting benefits, for the same period was $22,108 or $425 per year. The effect of upstream regulation and storage in Saskatchewan and North Dakota changes as the floods progress from Westhope to Wawanesa. Most of the agricultural damages due to floods in the Souris River valley in Manitoba would occur upstream of the town of Hartney. Damages would be relatively insignificant downstream of Hartney as the valley land is generally woodland. Agricultural damages from floods in the area are highly dependent upon the time, duration and magnitude of floods.

Table 5.12 Rafferty/Alameda Damage Increment Summary in 1982 Dollars

	Net Damages			Gross Damages		
Year	Agricultural	Urban	Total	Agricultural	Urban	Total
1969	-82,371	-300	-82,671	5,488	0	5,488
1974	-35,178	-9,300	-4,478	0	0	0
1975	-63,735	-16,200	-79,935	0	0	0
1976	-141,992	-10,500	-152,492	220	16,400	16,620
1979	-68,791	-25,300	-94,091	63	0	0
Total	-392,067	-61,600	-453,667	5,771	16,400	22,108
Average Annual 1936-1987	-7,539	-1,185	-8,724	110	315	425

[a] Difference between damages with and without Rafferty and Alameda operation. Benefits are ignored.
Source: Manitoba Water Resources Branch, 1988

Hydrologic simulations under post-construction operation conditions of the Project were used to assess the agricultural damages in Manitoba. These agricultural damages could be reduced through operational controls or covered through compensation.

5.4 Mitigation of Project Impacts in Saskatchewan, North Dakota and Manitoba

A comprehensive plan for joint Saskachewan-North Dakota-Manitoba operation of the Project is essential. Regular updates of this plan should be made. Accurate flood forecasting is needed to optimize benefits. Timing of releases is important even in winter when ice buildups can develop.

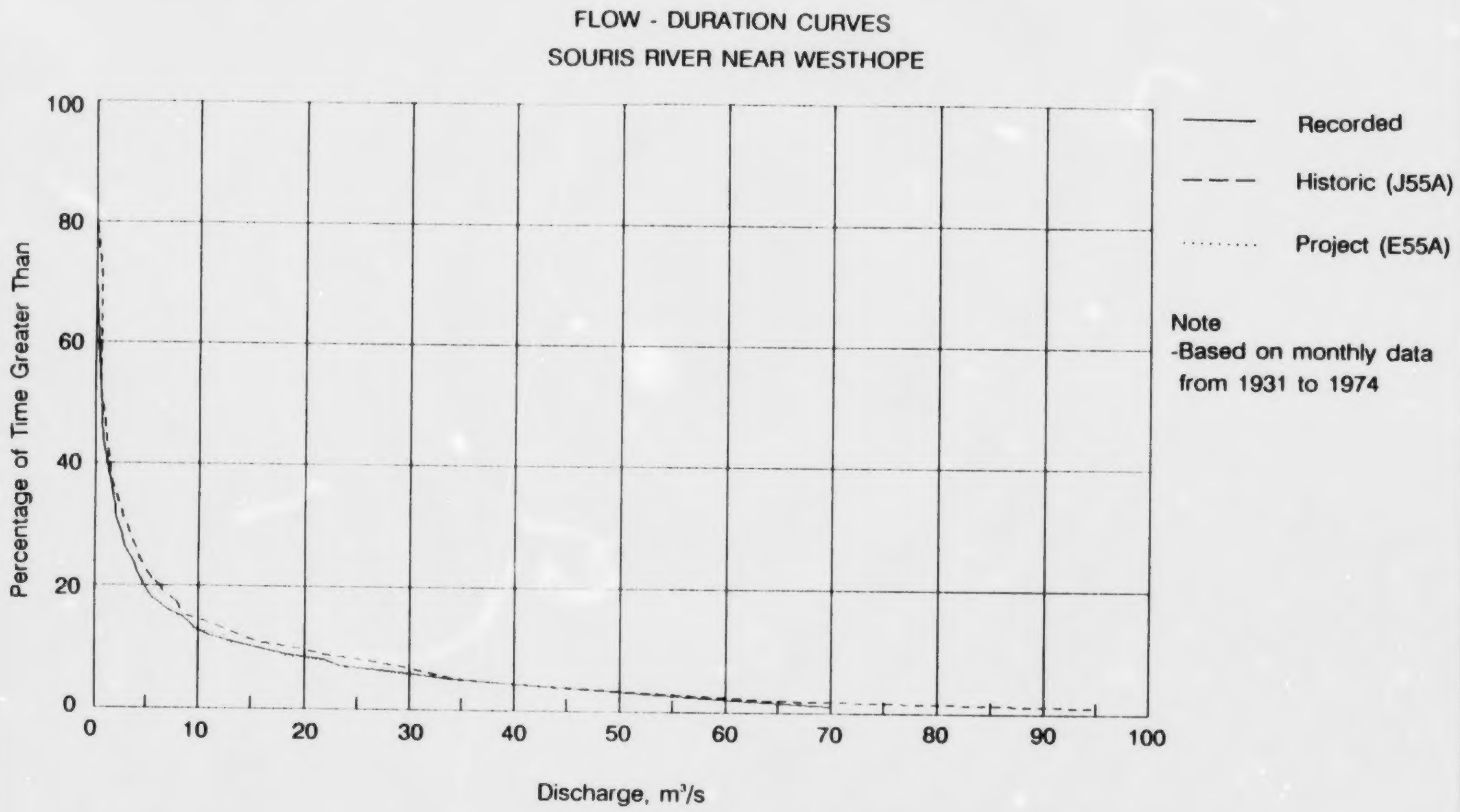
5.5 Summary

1. A common updated data base, although not essential, is highly desirable and should be prepared to include the most recent data.

2. Available evaporation estimates and flood frequency information appear adequate. If an updated data base is prepared, the evaporation component should be updated and included in natural flow calculations within the basin.

3. The hydrologic (WRMM) model layout appears adequate for scenario assessment, however, modelling became more elaborate as Project operations were refined during and after the preparation of the Saskatchewan EIS, and simulations prepared recently should not be compared with the earlier SBDA EIS simulations. The WRMM model was not examined in detail for the IEE. The model should be refined further to accommodate staged water use development in Saskatchewan, changing wildlife refuge operation in North Dakota and drought criteria applications at the North Dakota-Manitoba boundary. It is conceivable that the refuges in the United States are utilizing more water than their allocation in North Dakota.

4. The water use data from 1975 to present should be reviewed during any future update.



Environment Canada Conservation and Protection Environnement Canada Conservation et Protection	**Rafferty - Alameda Project** **Initial Environmental Evaluation**
	FIGURE: 5.15 Flow Duration Curve, Westhope
DATE: July, 1989	**SOURCE:** Environment Canada Conservation and Protection

6 INTERNATIONAL WATERS-WATER QUALITY

6.1 Existing Conditions

6.1.1 General

Water quality of the Souris River is variable throughout its length from the headwaters in southern Saskatchewan through North Dakota and on to its confluence with the Assiniboine River in Manitoba. Its quality reflects the extremes of the semi-arid continental climate, the glacial drift and enriched soils through which the river flows, the rural nature of the basin with few point sources of pollution, and the influence of several large impoundments along its course (Section 5 and Figure 6.1).

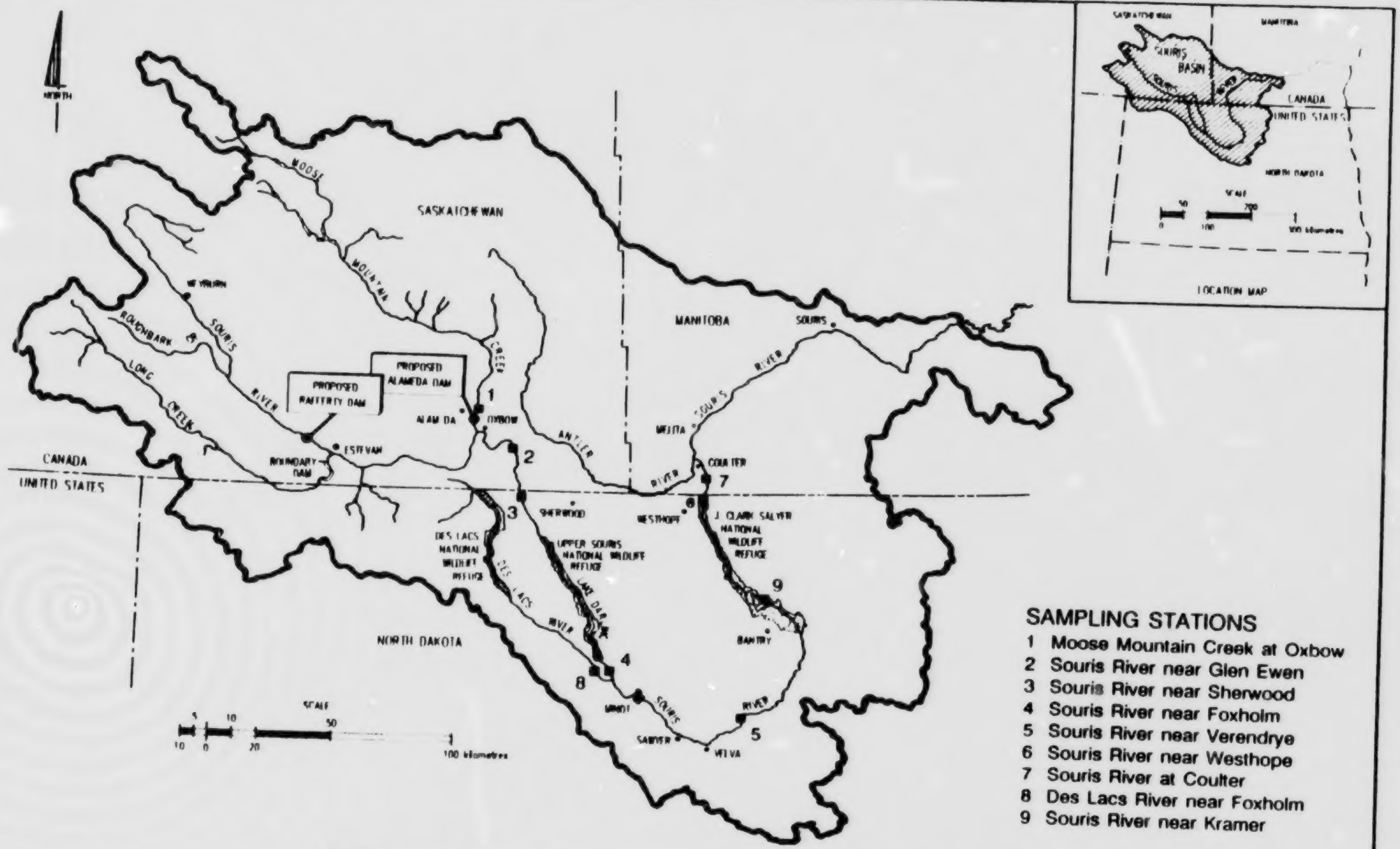
6.1.2 Information Sources and Data Handling

Throughout the water quality discussion, reference is made to many different locations and jurisdictions from which data have been reviewed (Figure 6.1 and Table 6.1). The evaluation of water quality relies heavily upon the hydrology of the Souris River before and following Project conditions. To obtain a good understanding of the hydrology, the reader is referred to Section 5.

Table 6.1. Souris River Basin Water Quality Information Locations

Station Description	Alternate Name	Operator*
Souris River at Hwy 18	Estevan	SDOEPS
Souris River near Glen Ewen	Glen Ewen	EC
Souris River near Sherwood	Sherwood	USGS/NDSDH
Souris River near Foxholm	Lake Darling	USGS/NDSDH
Lake Darling	Lake Darling	USGS/NDSDH
Souris River at Verendrye	Verendrye	USGS/NDSDH
Souris River above Minot	Minot	USGS/NDSDH
Souris River near Kramer	Kramer	NDSDH
Souris River near Westhope	Westhope	USGS/NDSDH
Souris River at Coulter	Coulter	EC
Moose Mountain Creek near Oxbow	Moose Mountain	EC/SDOEPS
Des Lacs River	Des Lacs	USGS/NDSDH

* USGS = United States Geological Survey; NDSHD = North Dakota State Department of Health; SDOEPS = Saskatchewan Department of Environment and Public Safety; EC = Environment Canada



SAMPLING STATIONS
1 Moose Mountain Creek at Oxbow
2 Souris River near Glen Ewen
3 Souris River near Sherwood
4 Souris River near Foxholm
5 Souris River near Verendrye
6 Souris River near Westhope
7 Souris River at Coulter
8 Des Lacs River near Foxholm
9 Souris River near Kramer

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Rafferty - Alameda Project Initial Environmental Evaluation

DATE: July, 1989

FIGURE: 6.1 Water Quality Sampling Stations

SOURCE: Environment Canada Conservation and Protection

Data and information on water quality, analytical methods, water uses, pollution sources and water management practices were obtained from environmental agencies of the Saskatchewan, Manitoba and North Dakota governments. Project-specific data and details were obtained from SBDA (1987) and supporting documentation. Scientific literature and scientists from these agencies and the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the U.S. Geological Survey, the Canadian water research institutes and Environment Canada, were consulted during the water quality evaluation.

Water quality is described using simple statistics of central tendency and variance. The suitability of water for supporting water uses has been evaluated relative to the Saskatchewan Surface Water Quality Objectives (Saskatchewan Environment and Public Safety 1989), Manitoba Surface Water Quality Objectives (Manitoba Environment, Workplace Safety and Health, July 1988), Standards of Water Quality for the State of North Dakota (North Dakota State Department of Health 1989) and the Canadian Water Quality Guidelines (CCREM 1987). Wherever possible, indicator or surrogate parameters have been presented rather than focusing on each and every parameter for which data exist. For example, total dissolved solids (TDS) is used as a surrogate for the major cations and anions which together make up TDS. The reader is reminded that the analysis contained herein has been conducted to meet the obligations of an Initial Environmental Evaluation, and therefore, does not provide the detail customarily found in an environmental impact statement.

The quality of international waters is considered on the basis of data provided for Glen Ewen, Saskatchewan, and Coulter, Manitoba. Data from other locations within the basin were used to help explain and understand the observations at these locations. Relationships of water quality chemistry to flow and the seasonal function have been considered. Biological aspects of aquatic quality are only briefly presented. However, Section 8.0 contains a more in-depth evaluation of basin fisheries and fish habitat. Fluvial and lacustrine peculiarities, to which biological communities have adjusted, are noted, as is the role wetlands play in moderating water quality.

6.1.3 Land and Water-based Activities Affecting Existing Quality

The most significant sources of industrial pollution in the Souris River basin are the coal mining operations and the coal-fired power plant at Boundary Reservoir in the western extremity of the upper Souris River basin (on Long Creek). Oil and gas exploration and production exist at a scale not believed to affect the quality of surface water. Industries located within the urban areas discharge directly into the municipal wastewater treatment systems. Municipal sewage discharges are the primary point sources of pollution (Table 6.2). For the most part, they are intermittent releases during spring, early summer, and in the late fall.

POINT SOURCE DISCHARGES IN THE SOURIS RIVER BASIN

Saskatchewan	Frequency of Discharge
Alameda	Semi-annual discharge
Arcola	Continuous overflow
Carlyle	Exfiltration
Ceylon	Semi-annual discharge
Corning	Semi-annual discharge
Estevan	Semi-annual discharge
Frobisher	Semi-annual discharge
Glen Even	Semi-annual discharge
Halbrite	Semi-annual discharge
Lampman	Semi-annual discharge
Manor	Semi-annual
Montmartre	Semi-annual discharge
Oxbow	Exfiltration
Radville	Semi-annual discharge
Stoughton	Semi-annual discharge
Torquay	Semi-annual discharge
Weyburn	Semi-annual discharge
Yellow Grass	Semi-annual discharge
Estevan Generating Station	Return cooling water
Boundary Dam Power Station	Return cooling water
North Dakota	
Towner	Annual discharge
Velva	2-3 times per year
Minot	5-7 times per year
Burlington	Has never discharged
Sawyer	Has never discharged
Westhope	Semi-annual discharge
Manitoba	
Hartney	Semi-annual discharge
Melita	Semi-annual discharge
Souris	Continuous discharge
Wawanesa	Continuous discharge

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TABLE: 6.2 Point Source Discharges in the Souris River Basin

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

According to the U.S. Army Corps of Engineers (1988), the city of Minot normally discharges treated municipal wastes twice annually. However, recent discharges were authorized as follows: 7 in 1986, 5 in 1987 and 7 in 1988. The U.S. Fish and Wildlife Service has indicated that the wastewater treatment lagoons often remain frozen until after late spring flows have passed. In order to meet State water quality standards, releases are not made under ice-cover (North Dakota State Department of Health 1989) and may therefore occur during early summer promoting algae blooms along the channel in the upstream pools of the refuge (U.S. Fish and Wildlife Service 1989). The Service implicates the treated municipal water from Minot and other municipalities in the deterioration of water quality in the J. Clark Salyer NWR. The Service further states, that on occasion, the natural filtering system of the refuge is overwhelmed with nutrient-rich water. These releases are also thought to be partially responsible for botulism outbreaks in waterfowl.

Agriculture dominates throughout the basin with only minor irrigation in the Canadian portion of the basin for market gardens and forage. The Eaton Irrigation District in North Dakota covers 4050 ha. Return flows are not known to be a water quality issue. Livestock operations, which are located within the floodplain or adjacent to waters draining into the Souris River, are a source of nutrients and bacterial contamination. The role of diffuse agricultural pollution is significant on a continental basis and is probably no more important in the Souris basin than it would be in any other basin of the prairies.

The only other major use of Souris River water is for maintaining the Upper Souris NWR near the Saskatchewan-North Dakota boundary and the J. Clark Salyer NWR located on the lower Souris River near the North Dakota-Manitoba boundary. The implications of these to water quality are discussed in Section 6.2.1.2.

6.1.4 Water Quality Characteristics

Although there is a general tendency towards better water quality under high flows, statistically defined relationships between specific chemical constituents and flow are not evident.

6.1.4.1 Physical Parameters

Physical attributes of the water, such as turbidity and suspended solids, differ at the two international boundary crossings of the Souris River. Lake Darling and J. Clark Salyer NWR probably contribute to these differences. Turbidity and suspended solids levels in the Souris River increase in the months of April to May near Glen Ewen due to higher flows, erosion and overland flow during spring runoff, whereas values increase at Coulter only slightly in spring and more noticeably in the fall, reflecting releases from J. Clark Salyer NWR. Mean water temperatures are higher and ranges are narrower at Coulter due to warming and damping of temperature fluxes in the impoundments upstream. Water temperature may be a limiting factor for survival of fish in July and August, especially in the lower reaches of the Souris River and shallow impoundments. Water quality attributes commonly associated with perception, namely colour, turbidity, biological growth and odour, frequently exist at levels that make this river unattractive for water contact activities.

The pH of the river is strongly influenced by biological productivity. This is particularly evident downstream of Lake Darling and J. Clark Salyer NWR. Values at Glen Ewen range from 6.7 to 8.8 (Table 6.3). Levels at Sherwood rarely exceed 8.5 (pH 8.5 is the North Dakota standard), whereas this level is frequently exceeded immediately downstream of Lake Darling. Further downstream, the lake influences are no longer evident and exceedances of standards are few in number. Below the refuge at Westhope, the 8.5 level is exceeded much of the time during the growing season. Similarly at Coulter, where pH values range from 5.7 to 9.6, values above 8.5 dominate from June to September.

6.1.4.2 General Aquatic Health Indicators

Dissolved oxygen frequently falls below levels required to sustain healthy fisheries. Diurnal fluctuations of 8 mg/L are not uncommon during the summer due to daily cycles of photosynthesis and respiration (Crosley and Munro 1984; Blachford 1987). Daily fluxes are lower in the fall and winter due to reduced biological activity and ice cover (Table 6.4). Broad fluctuations in dissolved oxygen concentrations are common throughout the historical record. According to the U.S. Army Corps of Engineers (1988), only in the Verendrye reach are dissolved oxygen ranges more limited. Lake Darling frequently experiences blue-green algae (Aphanizomenon flos-aquae) blooms during the summer (U.S. Army Corps of Engineers 1988) and subsequent periods of oxygen depletion following collapse of the blooms.

Winter fish kills occur in Lake Darling where water levels can fall below optimum, creating unfavourable oxygen conditions (Section 8). At Glen Ewen, the oxygen levels during the winter period of November to March are typically less than 50 percent saturation . At Coulter, 50 percent or less saturation is encountered during these same months and frequently during the summer. Oxygen depletion to zero is not uncommon in the month of February. Low dissolved oxygen levels in the summer are caused by oxygen demand for the biological breakdown of organic matter and respiration, whereas low winter levels are caused by reduced or inhibited oxygen exchange between the river or lake water and the atmosphere.

The organic carbon content of the river is derived from runoff, instream biological activity and from sources of sewage such as Estevan, Weyburn and Minot. Organic carbon concentrations range between 1 and 183 mg/L with a median of 16 mg/L at Glen Ewen, while concentrations at Coulter range from 4 to 58 mg/L with a median of 21 mg/L.

Prairie rivers typically have high levels of nutrients due to leaching and direct contribution from rich agricultural soils. Agricultural practices

SUMMARY OF WATER QUALITY DATA FOR SELECTED PARAMETERS
GLEN EWEN, SASKATCHEWAN and COULTER, MANITOBA

Parameter	Glen Ewen			Coulter		
	Median	Range	N*	Median	Range	N*
Total Dissolved Solids, mg/L	766	224-2095	76	661	205-1588	74
Dissolved Oxygen, mg/L	8.0	0.05-17.8	164	8.2	0-21.6	206
Turbidity, JTU	8.3	0.2-180	399	9.4	0.5-185	587
Non-filterable Residue, mg/L	16.0	0.5-225	256	18	0.5-300	384
pH	8.1	6.7-8.8	428	8.0	5.7-9.6	642
Temperature, °C	9.3	0-33	410	11.8	0-28.0	590
Sulphate (diss.), mg/L	214	50-814	397	167	4.8-1095	589
Boron (diss.), mg/L	0.33	0.005-1.20	162	0.25	0.005-1.27	187
Mercury (total), ug/L	0.010	0.01-0.12	94	0.01	0.005-0.110	126
Selenium (diss.) ug/L	0.0004	0-0.0034	136	0.0003	0-0.002	94
Total Nitrogen, mg/L	0.89	0.52-2.16	88	1.92	0.65-8.60	1284
Dissolved Nitrogen, mg/L	0.07	0.002-1.51	319	0.21	0.002-3.00	359
Total Phosphorus, mg/L	0.15	0.002-2.15	272	0.26	0.002-3.20	1745
Total Dissolved Phosphorus, mg/L	0.08	0.005-0.50	159	0.17	0.007-1.50	216
Total Ammonia, mg/L	0.10	0-5.0	226	0.10	0.01-3.20	204
Unionized Ammonia, mg/L	0.001	0-0.03	159	0.002	0-0.10	190

* N = Sample Size

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TABLE: 6.3 Summary of Water Quality for Selected Parameters

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SEASONAL SUMMARY OF SELECTED PARAMETERS FOR SOURIS RIVER NEAR GLEN EWEN AND COULTER

MEDIAN, (RANGE), N = SAMPLE SIZE

Parameter	Glen Ewen						Coulter					
	Spring		Summer		Ice Cover		Spring		Summer		Ice Cover	
	Mar 1 – May 31	N	Jun 1 – Oct 31	N	Nov 1 – Feb 28	N	Mar 1 – May 31	N	Jun 1 – Oct 31	N	Nov 1 – Feb 28	N
Total Dissolved Solids, mg/L	510(220-1736)	19	761(457-914)	33	1120(636-2095)	24	479(205-1637)	22	675(515-1196)	42	1223(922-1588)	10
Dissolved Oxygen, mg/L	9.0(0.05-17.8)	41	7.7(2.9-13.0)	87	9.0(0.25-13.1)	36	9.1(0-21.6)	60	8.1(1.3-19.7)	111	4.7(0.15.1)	95
Turbidity, JTU	10.5(0.2-180)	100	9.5(0.6-65)	175	6.1(1.0-60)	115	8.0(1.0-90)	168	12.0(0.5-100)	120	5.8(0.8-185)	91
Non Filterable Residue, mg/L	12(0.5-225)	76	19(0.5-150)	118	8(2-116)	62	13(0.5-192)	109	24(0.5-300)	311	8(1.0-227)	64
Sulphate (diss.), mg/L	181(58-720)	108	194(58-611)	174	340(127-816)	115	135(8-740)	170	148(24-617)	330	322(4-1095)	89
Boron (diss.), mg/L	0.31(0.10-1.20)	41	0.28(0.11-0.60)	49	0.44(0.005-1.20)	50	0.18(0.005-0.57)	52	0.24(0.005-1.27)	92	0.30(0.16-0.77)	61
Mercury (total), mg/L	0.01(0.01-0.06)	26	0.01(0.01-0.12)	61	0.01(0.01-0.07)	27	0.01(0.005-0.10)	33	0.01(0.005-0.11)	65	0.01(0.005-0.08)	20
Selenium (diss.), mg/L	0.0008(0-0.001)	12	0.0001(0-0.002)	61	0.0006(0.0002-0.002)	41	0.0001(0-0.002)	22	0.0001(0-.0007)	48	0.0004(0-0.001)	25
Total Nitrogen, mg/L	0.91(0.41-2.14)	26	0.83(0.53-1.48)	38	0.95(0.50-2.00)	26	1.3(0.65-7.85)	395	2.3(0.83-8.2)	663	2.0(0.01-8.6)	220
Dissolved Nitrogen, mg/L	0.27(0.002-1.15)	85	0.41(0.002-1.40)	166	0.10(0.002-1.91)	88	0.03(0.005-0.77)	118	0.11(0.002-1.0)	352	0.04(0.005-1.24)	19
Total Phosphorus, mg/L	0.18(0.05-0.45)	72	0.17(0.01-1.10)	131	0.10(0.002-2.15)	69	0.22(0.06-2.43)	460	0.28(0.002-1.9)	1061	0.10(0.02-1.2)	262
Total Dissolved Phosphorus, mg/L	0.08(0.01-0.30)	44	0.09(0.005-0.50)	82	0.05(0.01-0.45)	33	0.19(0.01-1.58)	57	0.20(0.007-0.83)	121	0.16(0.03-1.35)	16
Total Ammonia, mg/L	0.10(0.02-1.20)	66	0.05(0.01-5.0)	101	0.30(0.01-4.0)	30	0.08(0.01-2.7)	56	0.10(0.01-2.5)	106	0.36(0.01-1.2)	44
Unionized Ammonia, mg/L	0.001(0-0.01)	49	0.002(0.0001-0.06)	70	0.0009(0-0.01)	40	0.0009(0-0.01)	58	0.007(0.0001-0.10)	96	0.001(0-0.008)	10
N/P Ratio	5.0(3.1-21.0)	22	4.4(1.0-9.8)	16	8.4(4.0-21.5)	25	5.8(1.0-20.1)	369	7.9(2.1-10.6)	692	8.0(0.7-10.6)	160
pH	7.9(6.7-8.7)	115	8.1(6.9-8.8)	193	7.9(7.5-8.8)	120	7.7(7.6-7.8)	146	8.0(7.8-8.2)	197	7.8(7.1-8.2)	91
Temperature °C	6.5(0-19.5)	111	18.0(1-33)	106	0.5(0-22)	111	10.3(0-25.5)	167	19.5(0-28.0)	161	0.0(0-7.1)	80

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TABLE: 6.4 Seasonal Summary for Souris River

SOURCE: Environment Canada Conservation and Protection

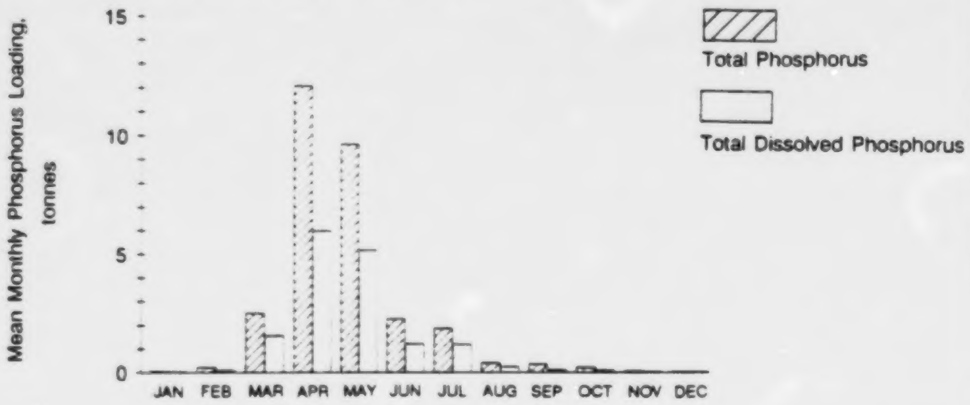
and sewage effluents add nutrients to the river, but the natural sources dominate. Of greatest concern to lakes is the total annual loading of phosphorus and nitrogen (Figure 6.2a and 6.2b) with as much as 65 to 80 percent of this being received during the high spring flows. Peak loadings normally occur at Glen Ewen in April and at Coulter in May. Figure 6.2a reveals a tendency for the total phosphorus loading at Coulter (Westhope) to be three times that recorded at Glen Ewen. Nitrogen increases by about four times. It is not known if the estimates over or under estimate actual loadings. Nevertheless, it is still abundantly clear that both nitrogen and phosphorus increase substantially within the U.S. portion of the Souris River basin. The role that the refuges play in the retention and release of phosphorus is uncertain, but it is noted that the average annual total phosphorus load at Glen Ewen (Sherwood) is 29.72 tonnes, near Kramer it is 59.73 tonnes, and near Coulter (Westhope) it is 90.77 tonnes. The relative contribution of the refuges, municipal effluents and diffuse source runoff to nutrient loading remains to be quantified for the Souris River Basin. Water management strategies in the future, will have to consider this relativity in order to establish priorities and options for nutrient control, as may be required.

The amount and availability of phosphorus and nitrogen determine the extent of growth of aquatic plants in the river, in Lake Darling and in the refuge impoundments. North Dakota has classified Lake Darling as a 2C cool water fishery, capable of supporting non-salmonid fishes and associated aquatic life. This classification recognizes that the lake is presently degraded (eutrophic) and is progressing toward further degradation. The river is rated as Class 1-A (highest state category), suitable for the propagation of resident fish species and for boating, swimming, and other water recreation (North Dakota State Department of Health 1989).

The median value of total phosphorus at Glen Ewen is 0.15 mg/L and at Coulter is 0.26 mg/L (Table 6.3). Relatively higher values occur at Glen Ewen in winter and late summer, and at Coulter in spring and summer. Dissolved phosphorus, the form most available for biological use, comprises over 50 percent of the total phosphorus present. Dissolved nitrogen values are higher downstream of the refuge impoundments (median 0.21 mg/L) than at Glen Ewen (median 0.07 mg/L). Levels of dissolved phosphorous and dissolved nitrogen rise at the downstream site over the growing season when a decrease would be expected because dissolved nutrients are actively taken up by aquatic plants. Nitrogen to phosphorus ratios at Coulter and Glen Ewen indicate a nitrogen-rich medium in summer and fall (Table 6.4).

Total ammonia concentrations are a concern in the river due to possible toxicity of its un-ionized fraction to fish and other aquatic life. The occurrence of elevated levels of un-ionized ammonia (henceforth referred to as free ammonia) appear to be directly attributable to reservoir and wetland productivity. Levels of free ammonia are enhanced by increases in pH and temperature, and its toxicity is also affected by dissolved oxygen levels. Chacko (1986) reports that during the winter, total ammonia can be as much as 52 percent of the total nitrogen forms present in the water.

MEAN MONTHLY PHOSPHORUS LOADING
SOURIS RIVER near GLEN EWEN, SASKATCHEWAN



MEAN MONTHLY PHOSPHORUS LOADING
SOURIS RIVER near COULTER, MANITOBA

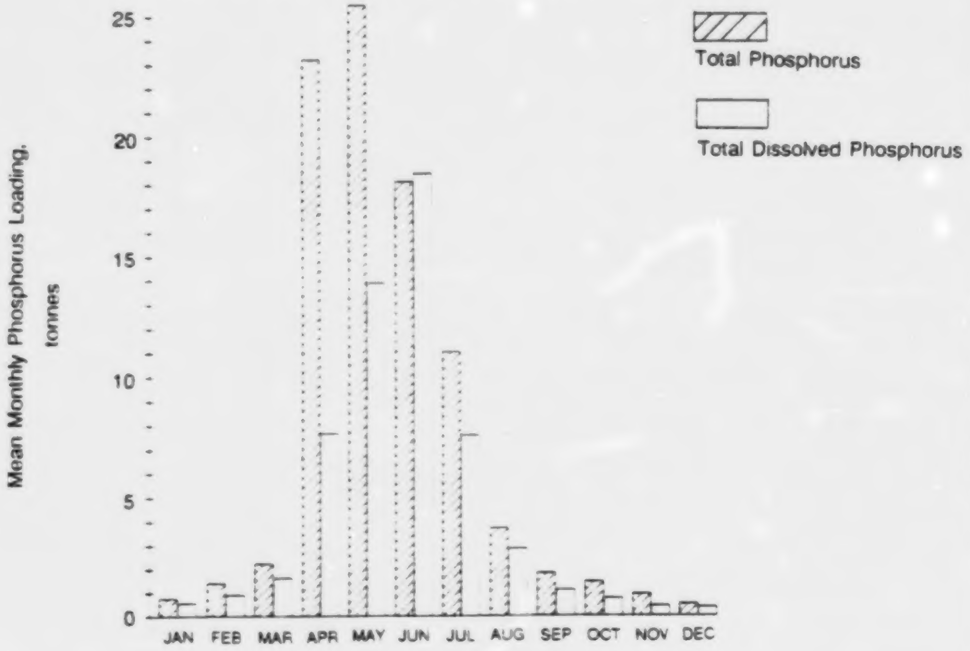


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FIGURE: 6.2a Phosphorus Loading at Glen Ewen and Coulter

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

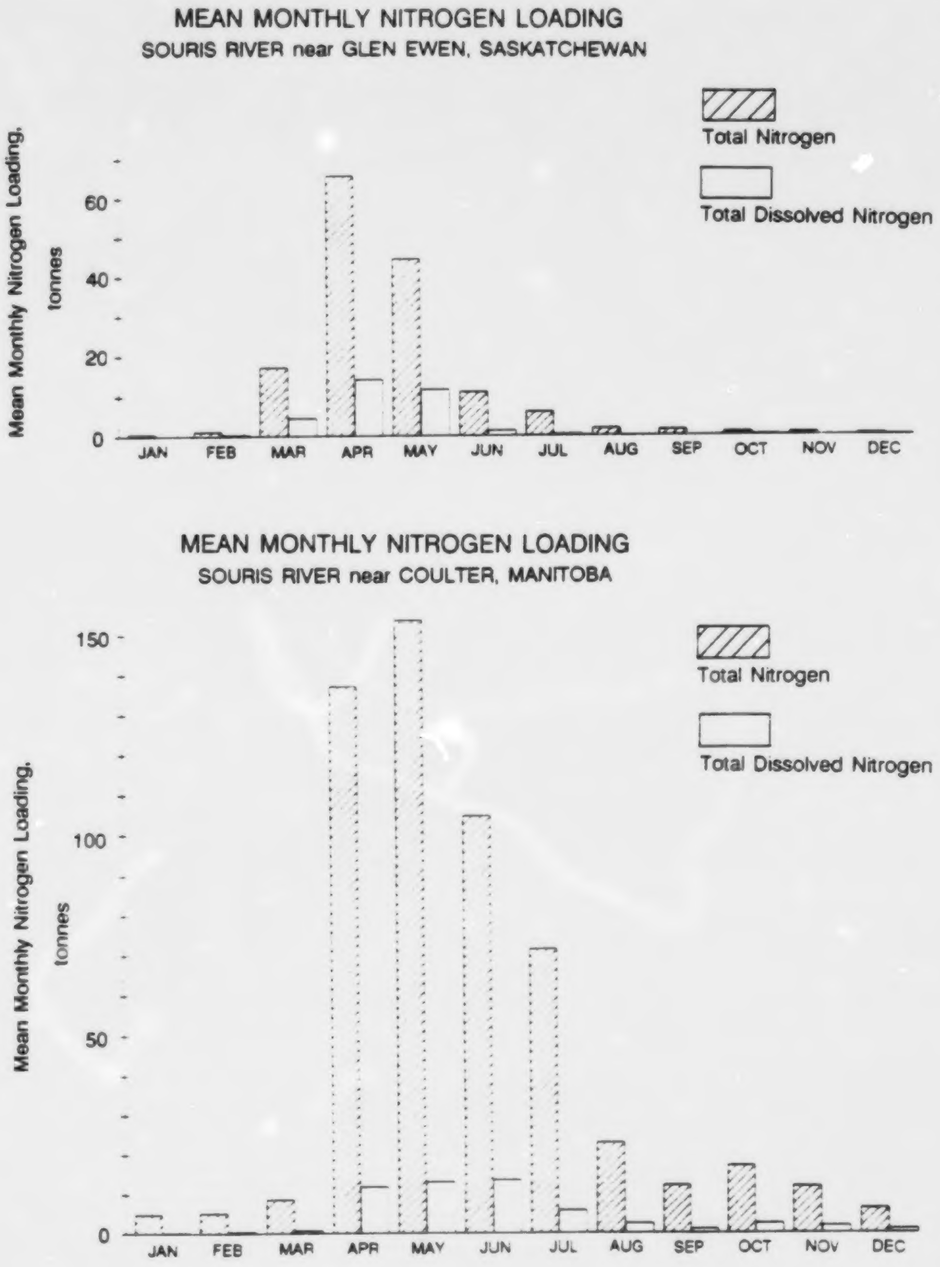

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FIGURE: 6.2b Nitrogen Loading at Glen Ewen and Coulter

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

The cold temperatures help keep the free ammonia concentrations depressed. Free ammonia levels exceed the North Dakota standard of 0.02 mg/L most frequently in the reach downstream of Lake Darling and J. Clark Salyer NWR (U.S. Army Corps of Engineers 1988). The historical data base and a study conducted by Blachford (1989) confirm that the early fall period is the most likely time during which ammonia levels may be toxic (Figure 6.3). The fall period, when flows are increased due to refuge releases, is characterized by an abundance of decomposing organic material.

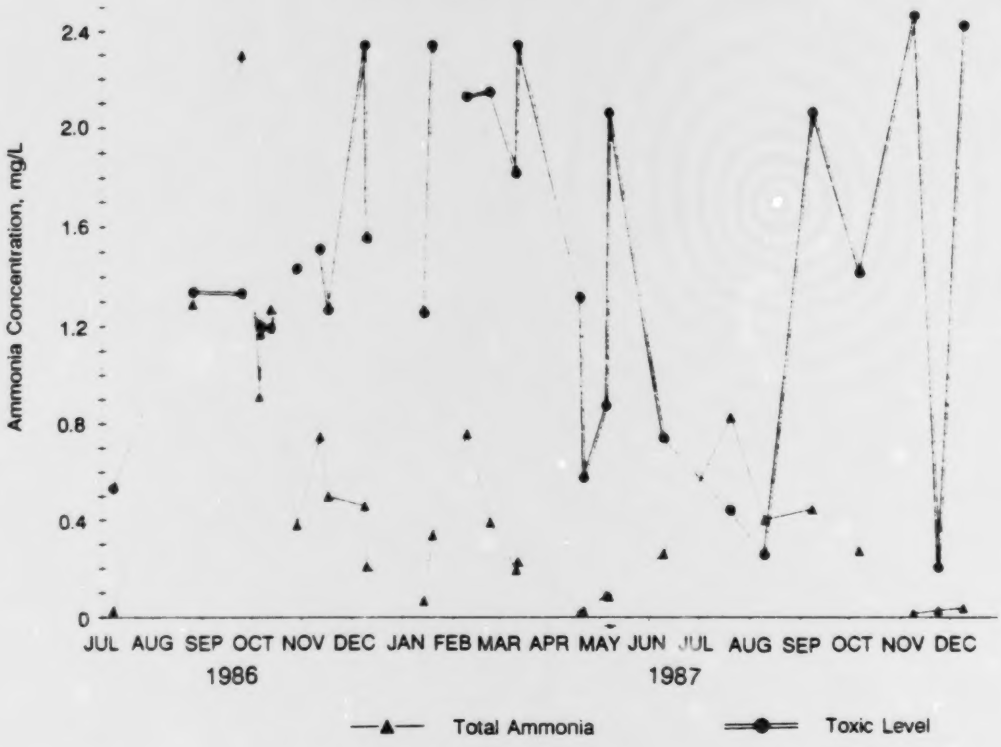
6.1.4.3 Dissolved Solids

The salt content of the Souris River, measured by total dissolved solids (TDS) concentrations, varies seasonally and by river reach. Concentrations are lowest in spring due to high flow dilution and less contact with soil minerals and highest in winter due to ice formation and ground water inputs during low flow (Table 6.4). Levels at Glen Ewen range from 224 to 2095 mg/L, with a median of 766 mg/L. Values at Sherwood are similar with a median of 740 mg/L and a range of 159 to 1810 mg/L, while levels downstream of Lake Darling have a median of 531 mg/L and vary within a narrower range of 222 to 1090 mg/L. Further downstream, the median value is 686 mg/L and values vary more widely between 151 and 1530 mg/L due to evaporation and tributary inputs. At Coulter, values vary widely between 205 and 1588 mg/L around a median of 661 mg/L.

The downstream tendency towards lower TDS reflects the diluting influence of the Des Lacs River and the moderating effect of Lake Darling caused by mixing of the river water with stored good quality snow-melt water. Point source pollution of dissolved solids is restricted to sewage inputs. The most dominant factors affecting the salinity of the river are evaporation (highest from existing shallow pools and Lake Darling), ground water input and watershed geology.

Sulphates and bicarbonates are the predominant anions in basin waters. The North Dakota standard for sulphate (450 mg/L) has often been exceeded at several sites (Sherwood, Verendrye and Westhope), and the Manitoba objective (250 mg/L) has been exceeded in 26 percent of samples collected at Coulter. The exceedances occur more frequently over the winter period when the highly mineralized ground water contribution to stream flow is proportionally higher.

The quality of water in Moose Mountain Creek is superior to that of the Souris River in virtually all its attributes (Figures 6.4a and b, Tables 6.5 and 6.6). For example, the median total dissolved solids concentration of the creek is 583 mg/L with a maximum of 1248 mg/L, while the Souris at Glen Ewen has a median of 766 mg/L and a maximum of 2095 mg/L. Nutrient values in the Creek occur at about half the concentration of those in the Souris River. However, free ammonia values exceed the standard of 0.02 mg/L 10 percent of the time, whereas values at Glen Ewen are in exceedance 2 percent of the time.



TOTAL AMMONIA CONCENTRATIONS RELATIVE TO THE CALCULATED AMMONIA CONCENTRATION AT WHICH ACUTE TOXICITY CAN OCCUR
(SOURIS RIVER AT COULTER)

Historical Values of Total Ammonia

Spring (March 1 - June 14)

Maximum 2.7 mg/L
Median 0.06 mg/L
Minimum 0.01 mg/L

Open (June 15 - November 30)

Maximum 2.5 mg/L
Median 0.10 mg/L
Minimum 0.01 mg/L

Ice Cover (December 1 - February 28)

Maximum 3.2 mg/L
Median 0.36 mg/L
Minimum 0.01 mg/L

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FIGURE: 6.3 Total vs Toxic Levels of Ammonia at Coulter

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

WATER QUALITY OF MOOSE MOUNTAIN CREEK AND SOURIS RIVER
NEAR GLEN EWEN AND COULTER

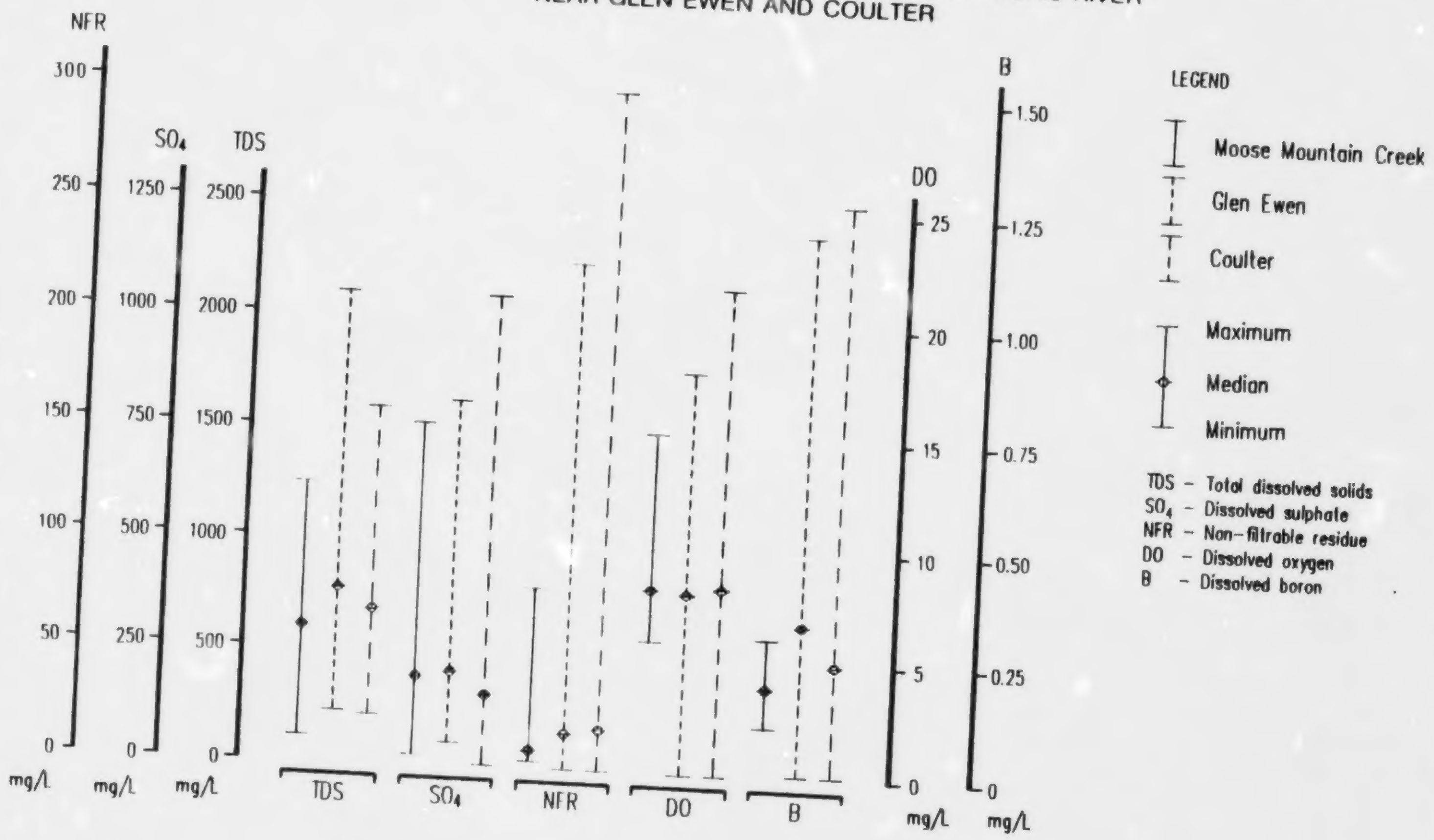

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FIGURE: 6.4a Water Quality Ranges for Selected Parameters

SOURCE: Environment Canada Conservation and Protection

WATER QUALITY OF MOOSE MOUNTAIN CREEK AND SOURIS RIVER
NEAR GLEN EWEN AND COULTER

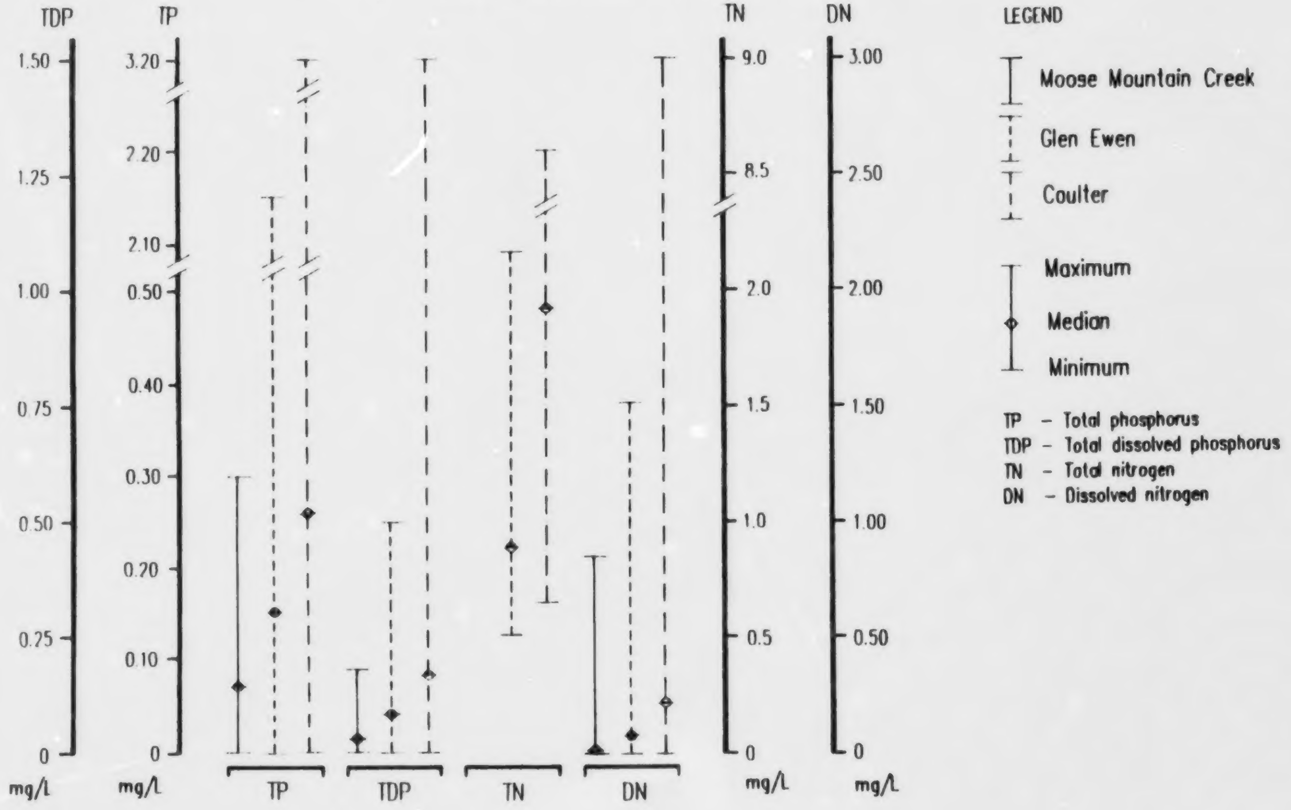

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	FIGURE: 6.4b Water Quality Ranges for Selected Parameters
DATE: July, 1989	**SOURCE:** Environment Canada Conservation and Protection

WATER QUALITY SUMMARY OF SELECTED PARAMETERS FOR MOOSE MOUNTAIN CREEK AND SOURIS RIVER AT GLEN EWEN

Parameter	Moose Mountain Creek			Souris River		
	Median	Range	N*	Median	Range	N*
Total Dissolved Solids, mg/L	583	102 - 1248	64	766	224 - 2095	76
Non-filterable Residue, mg/L	8.2	3 - 80	48	16.0	0.5 - 225	256
Turbidity, JTU	4.0	0.5 - 80	50	8.3	0.2 - 180	399
Temperature, °C	16.5	0 - 25	63	9.3	0 - 33	410
Dissolved Oxygen, mg/L	8.2	5.7 - 15.1	54	8.0	0.05 - 17.8	164
pH	8.3	6.9 - 8.7	63	8.1	6.7 - 8.8	428
Sulphate (diss.), mg/L	195	23 - 760	49	214	50 - 814	397
Boron (diss.), mg/L	0.19	0.11 - 0.30	8	0.33	0.005 - 1.2	162
Total Phosphorus, mg/L	0.074	0.001 - 0.30	55	0.15	0.0 - 2.15	272
Total Dissolved Phosphorus, mg/L	0.03	0.01 - 0.18	43	0.08	0.005 - 0.5	159
Nitrogen (diss.), mg/L	0.01	0.005 - 0.84	46	0.07	0.002 - 1.51	319
Total Ammonia, mg/L	0.05	0.01 - 1.0	51	0.10	0 - 5	226
Unionized Ammonia, mg/L	0.002	0 - 0.08	48	0.001	0 - 0.03	159

* N = Sample Size

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TABLE: 6.5 Water Quality of Moose Mountain Creek & Souris River

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SEASONAL WATER QUALITY SUMMARY OF SELECTED PARAMETERS FOR MOOSE MOUNTAIN CREEK

MEDIAN, (RANGE), N = SAMPLE SIZE

Parameter	Spring		Summer		Ice Cover	
	Mar 1 - May 31	N	Jun 1 - Oct 31	N	Nov 1 - Feb 28	N
Total Dissolved Solids, mg/L	388(102-819)	24	639(462-1116)	38	1038(828-1248)	2
Dissolved Oxygen, mg/L	9.8(7.3-15.1)	20	7.6(5.7-11.9)	33	11.1	1
Turbidity, JTU	3.4(1.0-28)	23	4.5(0.5-80)	25	3.1(2.2-4.0)	2
Non-filterable Residue, mg/L	11(3-80)	19	7(3-31)	29		0
Sulphate (diss.), mg/L	151(23-479)	22	228(167-760)	25	598(438-759)	2
Boron (diss.), mg/L	0.14(0.11-0.15)	3	0.22(0.2-0.3)	3	0.21(0.18-0.24)	2
Dissolved Nitrogen, mg/L	0.02(0.005-0.84)	17	0.005(0.005-0.05)	27	0.02(0.01-0.04)	2
Total Phosphorus, mg/L	0.06(0.04-0.30)	20	0.07(0.001-0.17)	35		0
Total Dissolved Phosphorus, mg/L	0.03(0.02-0.18)	16	0.03(0.01-0.12)	27		0
Total Ammonia, mg/L	0.05(0.01-0.3)	20	0.05(0.01-1.0)	31		0
Unionized Ammonia, mg/L	0.0006(0.0001-0.007)	19	0.005(0.0007-0.08)	29		0
pH	8.0(6.9-8.4)	23	8.4(7.9-8.7)	38	8.2(8.2-8.3)	2
Temperature, °C	10.4(0.6-22.0)	24	20.0(5-25)	36	0.3(0-1.0)	3

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TABLE: 6.6 Seasonal Summary for Moose Mountain Creek

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

The Souris River at both international boundary crossings is dominated by bicarbonate salts (Table 6.7). The upper reaches of the Souris River and Moose Mountain Creek, which frequently have base flows, have sulphate to bicarbonate ratios that invert over the course of the annual hydrologic cycle. Table 6.7 shows that during high flows Moose Mountain Creek has similar amounts of bicarbonate and sulphate. During the fall and winter low flow periods when ground water is a greater proportion of the surface water flow, sulphates clearly dominate.

6.1.4.4 Sodium Adsorption Ratio, Boron and Selenium

The sodium adsorption ratio (SAR) is an estimate of the degree to which sodium would be adsorbed from water to soil particles. It is important in evaluating the suitability of water for irrigation. SAR values at Glen Ewen (mean 3.73, range 2.12-5.65) are slightly higher than those at Coulter (mean 2.85, range 1.44-4.47). SAR levels for the Souris River are at acceptable levels for irrigation use.

Boron in water is derived largely from leaching of soils, and therefore, levels can be increased by agricultural activity. Large amounts of boron in irrigation waters may damage certain crops. Dissolved boron at Glen Ewen ranges from 0.005 to 1.20 mg/L with a median of 0.33 mg/L (Table 6.3). The Saskatchewan water quality objective for sensitive crops such as wheat and barley is 0.5 - 1.0 mg/L. The lower end of this range is exceeded for 15 percent of samples and at Sherwood for only 1.4 percent of samples. Boron levels at Coulter show a similar range of 0.005 to 1.27 mg/L with a median of 0.25 mg/L. The Manitoba objective for boron is 1.0 mg/L and is rarely exceeded. Boron levels are highest over the low flow winter period and lowest during spring runoff. As higher levels of boron exist in ground than in surface waters, ground water pumping could increase surface water concentrations. For example, boron levels in Boundary Reservoir rose from a level of 3 mg/L in October 1987 to about 6 mg/L in the winter of 1989 due to ground water pumping and evaporation in the reservoir.

Selenium does not appear to be a concern in the basin as maximum values of dissolved selenium at Glen Ewen (0.003 mg/L) and Coulter (0.002 mg/L) fall well below the North Dakota standard and Manitoba objective of 0.01 mg/L.

6.1.4.5 Metals

There is no known industrial point source of mercury or any other toxic metal (e.g. cadmium, lead, chromium, nickel or copper) to the Souris River or its tributaries. Low levels of metals occurring in the Souris River basin (rarely exceeding the analytical detection limit) are due to natural sources. Iron and managanese concentrations periodically exist at natural levels which could cause laundering problems for domestic water users of the Souris River. Current median levels of total mercury in water at Glen Ewen and Coulter are 0.010 ug/L, and range from 0.005 to 0.12 ug/L. These levels, likely released from basin soils, frequently exceed the North Dakota standard of 0.012 ug/L for protection of aquatic life. The

RELATIVE ABUNDANCE OF ANIONS ON MOOSE MOUNTAIN CREEK AND SOURIS RIVER WATERS

	Season *			Season *		
Mean Conc.	SP	SM	FW	SP	SM	FW
	Sulphate			Bicarbonate		
			Moose Mountain Creek, Saskatchewan			
mg/L	216	300	899	276	397	633
meq/L	4.5	6.3	18.7	4.5	6.5	10.4
N**	24	26	5	23	26	4
			Glen Ewen, Saskatchewan			
mg/L	209	203	361	286	406	567
meq/L	4.4	4.2	7.5	4.7	6.7	9.3
N**	108	174	115	19	33	24
			Coulter, Manitoba			
mg/L	161	183	323	340	371	635
meq/L	3.4	3.8	6.7	5.6	6.1	10.4
N**	143	310	136	19	38	27

* SP = Spring (March 1 to May 31)
SM = Summer (June 1 to October 31)
FW = Fall-Winter (November 1 to February 28) (Ice)
** N = Sample Size

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Initial Environmental Evaluation

TABLE: 6.7 Relative Abundance of Anions

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

exceedances show no seasonal pattern. Mercury has been detected in the muscle tissue of sports fish species in the basin at levels exceeding the Manitoba and Canadian objective of 0.5 ug/g and occasionally exceeding the United States Standard of 1.0 ug/g.

6.1.4.6 Pesticides

There are no significant sources of industrial contaminants within the Souris River Basin. Agriculture is the dominant industry, and as such, pesticides are the main contaminant. Pesticides may reach the aquatic environment through non-target application (as from wind drift), direct application of pesticides to control aquatic weeds, through diffuse runoff from agricultural lands, irrigation return flow, and to a limited extent from domestic practices. Detections of pesticides in surface water occur in the basin for lindane, alpha-HCH, 2,4-D and 2,4,5-T, as is common across the Prairies. Only isolated detections of MCPB, heptachlor, heptachlor epoxide, chlordane, dieldrin, aldrin, dimethoate, DDE, triallate, trifluralin, atrazine, and Hoegrass have been recorded. Subsurface water contamination has not been reported, therefore, ground water is not likely a significant pathway by which pesticides presently reach the Souris River. Herbicides have not been detected in aquatic sediments collected in the basin. Pesticides have not been found to exist within the basin at levels known to be harmful to humans or aquatic life nor have any been observed to accumulate in biota.

6.1.4.7 Biology

Over much of its length, the Souris River's biological quality, measured in terms of its diversity and community structure, is typical of a prairie system. In the reaches below Lake Darling where flows are regulated, the biological community is more reflective of a slow moving stream, rather than of a stagnant one as often occurs in the Saskatchewan portion of the Souris River during the summer periods.

The bacteriological quality of the river is highly variable, depending on flow conditions and the nature of discharges upstream. High levels of total and fecal coliforms have been recorded at the Saskatchewan-North Dakota boundary, possibly because of sewage discharges from Estevan. Similarly, at the North Dakota-Manitoba boundary, high coliform levels have been periodically recorded. The most probable source of contamination is the J. Clark Salyer NWR located just a few kilometres upstream. The high use of this refuge by ducks and geese may give rise to fecal contamination before, during and after drawdown of the pools. On the basis of monthly sampling since 1974, fecal coliform levels at both boundaries range between 0 and 2500 counts/100 mL (Table 6.8). Fecal coliform levels exceeded the Saskatchewan water quality objectives, the North Dakota standards and Canadian water quality guidelines in 58 percent of the samples. Swimming and other direct water contact recreation is not thought to exist within the river reaches where these levels are highest.

Table 6.8 **Bacteriological Quality of International Waters**
(Counts/100 mL)

	Minimum	Maximum	Median
Glen Ewen			
Total Coliform	1	4000	50
Fecal Coliform	1	2500	18
Coulter			
Total Coliform	1	2320	31
Fecal Coliform	0	2300	11

In its natural state, the Souris River water quality would probably have been characterized by naturally high nutrient levels, low oxygen during winter, highly variable TDS concentrations in all seasons, and periods of extreme high flow and no-flow. Under no-flow conditions, reaches of the Souris River would dry up, and aquatic life forms would perish or persist as dessication-resistant stages such as plant seeds or invertebrate eggs.

The benthic invertebrate fauna of the Souris River includes freshwater shrimp (Amphipoda), midge larva (Diptera), mayfly larva (Ephemeroptera), snails and fingernail clams (Mollusca), worms (Oligochaeta), and caddisfly larva (Trichoptera). Most of the aquatic fauna that currently live in the Souris River have probably inhabited this river for centuries. These species have adapted to the extreme chemical and physical conditions in the river. Following periods of extended drought, many species can probably colonize areas of the basin that have dried up.

Aquatic plants are also common, both within existing reservoirs and the mainstem Souris River. Water plantain, hornwort, water milfoil, duckweed, bladderwort, pondweed, and cattail (Sagittaria, Ceratophyllum, Hippurus, Lemna, Utricularia, Potamogeton, and Typha, respectively) have been recorded from within the basin. Extensive growths of filamentous algae (Cladophora and Spirogyra) are also common. In the Manitoba portion of the basin, Cladophora is a recurring problem during low flows and high summer temperatures.

Plants are an important component of aquatic ecosystems providing food and cover for invertebrates, turtles, fish and waterfowl. In its natural state, the Souris River probably supported substantial growths of aquatic plants, although in recent decades, plant productivity may have increased because of sewage effluent discharge and the use of agricultural fertilizers.

Forty species of fish have been recorded for the Souris River in Saskatchewan, North Dakota and Manitoba. Aspects of the distribution, abundance, and significance of fish and fisheries within the basin are discussed in Section 8.

6.1.5 Overview Statement

The quality of the two major tributaries, Moose Mountain Creek and Des Lacs River, is superior to that of the Souris River, and they serve to dilute poorer quality Souris River water. The quality of the Souris River improves in a downstream direction for dissolved salts but degrades relative to nutrients. The main factors are the refuges, municipal effluents, and diffuse source inputs from agricultural runoff. Water at the North Dakota-Manitoba boundary possesses significantly higher nutrient levels than that at the Saskatchewan-North Dakota Boundary.

The existing water quality concerns throughout the basin relate to dissolved oxygen depletion, and increases in TDS and free ammonia that occur under low flow or no flow conditions coupled with high temperatures. A comparison of a large number of water chemistry attributes with provincial objectives, North Dakota standards and the Canadian guidelines is given in Table 6.9. It is recognized that existing conditions for some portions of the year or for selected reaches of the river may exceed standards (or guidelines and objectives), while at other times, or in other places, the concentrations of pollutants may be at levels below the standards. Naturally occurring conditions are thought to exist which exceed standards. Man-induced perturbations may be masked by existing quality or may exacerbate the prevailing situation (e.g. low dissolved oxygen).

The quality of water at the Saskatchewan-North Dakota boundary is now being affected by land and water-based activities upstream. The natural flows of the river have been altered by the construction of Boundary Dam, Weyburn Reservoir and instream impoundments; however, approximately 84 percent of the annual flow still crosses the boundary unaltered. Therefore, flow regulation has probably not yet altered natural water quality significantly.

The refuges, municipal discharges and agricultural runoff are sources of nutrient enriched water. These and natural conditions, coupled with low flows, create undesirable aesthetic conditions in the Souris River downstream.

Although the quality of Souris River water does not consistently meet water use guidelines, water quality objectives or standards (Table 6.9), the single greatest limitation to water use is the quantity of water available (Section 5).

EXCEEDANCES OF GUIDELINES, OBJECTIVES AND STANDARDS AT GLEN EWEN AND COULTER

% IS PROPORTION OF SAMPLES IN EXCEEDANCE, AND ( ) REPRESENTS RANGE OF EXCEEDANCES

Parameter	CCREM Guidelines	Saskatchewan Objectives	North Dakota Standards	Manitoba Objectives
Aldrin			30 ug/L	
Glen Ewen			0	
Coulter			0	
Ammonia	2.2-1.37 AL* (Total)			0.0184-0.05 mg/L (Free)
Glen Ewen	2.9% (1.40-2.83 mg/L)			0.2% (0.026-0.037)
Coulter	6.8% (1.45-2.7 mg/L)			11.7% (0.019-0.108)
Arsenic	0.05 mg/L DW, AL	0.05 mg/L	0.05 mg/L	0.05 mg/L
Glen Ewen	0	0	0	0
Coulter	0	0	0	0
Barium	0.1 mg/L	1.0 mg/L AL	1.0 mg/L	1.0 mg/L
Glen Ewen	14% (0.113-0.21 mg/L)	0	0	0
Coulter	90% (0.102-0.37 mg/L)	0	0	0
Boron	0.5-6.0 mg/L IR	0.5 mg/L IR	0.75 mg/L	1.0 mg/L IR
Glen Ewen	15% (0.52-1.2 mg/L)	15% (0.52-1.2 mg/L)	2% (0.89-1.2 mg/L)	1% (1-1.2 mg/L)
Coulter	7.5% (0.51-1.27 mg/L)	7.5% (0.51-1.27 mg/L)	1% (0.77-1.27 mg/L)	0.5% (1.27 mg/L)
Cadmium	0.1 mg/L IR	0.001 mg/L AL		0.005 mg/L DW
Glen Ewen	0	0		(acid soluble)
Coulter	0	0		
Calcium	1000 mg/L LV			
Glen Ewen	0			
Coulter	0			
Chloride	100-700 mg/L IR	250 mg/L DW	175 mg/L	68 mg/L (soluble) IR
Glen Ewen	13% (100-268 mg/L)	0.43% (268 mg/L)	0.8% (216-268 mg/L)	
Coulter	0.3% (115 mg/L)	0	0	
Cobalt	0.05-5.0 mg/L IR	0.05 mg/L IR		0.05 mg/L
Glen Ewen	0	0		0
Coulter	0	0		0
Copper	0.002-0.004 mg/L AL	0.01 mg/L AL	0.05 mg/L	0.0065 mg/L AL
Glen Ewen	40%(0.0022-0.028 mg/L)	8.6% (0.01-0.028 mg/L)	0	(acid soluble)
Coulter	36%(0.0021-0.038 mg/L)	5.3% (0.01-0.038 mg/L)	0	

* DW: Drinking Water
AL: Aquatic Life
IR: Irrigation
LV: Livestock Watering
RC: Recreation

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Initial Environmental Evaluation

TABLE: 6.9 Exceedances of Guidelines, Objectives and Standards

SOURCE: Environment Canada Conservation and Protection

Parameter	CCRFM Guidelines	Saskatchewan Objectives	North Dakota Standards	Manitoba Objectives
Cyanide	0.2 mg/L DW	0.01 mg/L	0.005 mg/L	0.0052 mg/L (free)
Glen Ewen	0	16% (0.013-0.057 mg/L)	44% (0.006-0.057 mg/L)	
Coulter	0	21% (0.01-1.7 mg/L)	56% (0.006-0.17 mg/L)	
Dicamba	0.12 mg/L DW			
Glen Ewen	0			
Coulter	0			
Diclofop-methyl	0.009 mg/L			
Glen Ewen	0			
Coulter	0			
Dieldrin			0.002 ug/L	0.0019 ug/L
Glen Ewen			0	0
Coulter			0	0
Dissolved Oxygen	5.0-9.5 mg/L AL	5 mg/L	5 mg/L	47% saturation
Glen Ewen	15%(0.05-4.8)max.17.8	15% (0.05-4.8)	15% (0.05-4.8)	
Coulter	17% (0-4.8) max. 21.0	17% (0-4.8)	17% (0-4.8)	
Endrin	0.2 ug/L	0.2 ug/L DW	0.06 ug/L	0.2 ug/L
Glen Ewen	0	0	0	0
Coulter	0	0	0	0
Fecal Coliforms	200/100 ml RC	100/100 ml	200/100 ml	200/100 ml AL, RC
Glen Ewen	8.8% (210-2500)	11.3% (1200-2500)	8.8% (210-2500)	
Coulter	5.8% (210-2300)	11.2% (103-2300)	5.8% (210-2300)	
Fluoride	1.0-2.0 mg/L LV	1.0 mg/L IR		1.0 mg/L IR
Glen Ewen	0	0		0
Coulter	0	0		0
Heptachlor			0.004 ug/L	0.0038 ug/L
Glen Ewen			0	0
Coulter			0	0
Iron	0.3 mg/L DW, AL	0.3 mg/L		0.3 mg/L
Glen Ewen	2.5% (0.330 mg/L)	2.5% (0.33 mg/L)		2.5% (0.33 mg/L)
Coulter	4% (0.32-1.12 mg/L)	4% (0.32-1.12 mg/L)		4% (0.32-1.12 mg/L)

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Rafferty - Alameda Project
Initial Environmental Evaluation

TABLE: 6.9 Continued

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

Parameter	CCREM Guidelines	Saskatchewan Objectives	North Dakota Standards	Manitoba Objectives
Lead	0.001-0.007 mg/L AL	0.02 mg/L AL	0.05 mg/L (diss.)	0.03 mg/L AL
Glen Ewen	20% (0.001-0.003 mg/L)	0		0
Coulter	31% (0.001-0.005 mg/L)	0		0
Lindane	4 ug/L DW	4 ug/L DW	0.06 ug/L	0.08 ug/L AL
Glen Ewen	0	0	0	0
Coulter	0	0	0	0
Manganese	0.05 mg/L DW	0.05 mg/L DW		0.05 mg/L
Glen Ewen	71% (0.06-1.4 mg/L)	71% (0.06-1.4 mg/L)		71% (0.06-1.4 mg/L)
Coulter	51% (0.057-0.22 mg/L)	51% (0.057-0.22 mg/L)		51% (0.057-0.22 mg/L)
Mercury	0.1 ug/L	0.1 ug/L AL	0.012 ug/L	0.006 ug/L DW
Glen Ewen	2.1% (0.11-0.12 ug/L)	2.1% (0.11-0.12 ug/L)	23% (0.02-0.12 ug/L)	(acid soluble)
Coulter	0.7% (0.11 ug/L)	0.7% (0.11 ug/L)	35.7% (0.02-0.11 ug/L)	
Methoxychlor	0.1 mg/L DW	0.1 mg/L DW		0.1 mg/L DW
Glen Ewen	0	0		0
Coulter	0	0		0
Nickel	0.2-2.0 mg/L	0.2 mg/L IR		56 ug/L
Glen Ewen	0	0		(acid soluble)
Coulter	0	0		
Non-filterable Residue				25 mg/L
Glen Ewen				36% (25.2-225 mg/L)
Coulter				39% (26-300 mg/L)
pH	6.5-8.5	6.5-8.8	7.0-9.0	6.5-8.5
Glen Ewen	4% (8.6-8.8)	0	0	4% (8.6-8.8)
Coulter	0.3% (5.7-6.4)	0.3% (5.7-6.4)	0.9%(5.7-6.8)	0.3% (5.7-6.4)
Coulter	15% (8.6-9.6)	15% (8.6-9.6)	3% (9.1-9.6)	15% (8.6-9.6)
Phenols	1.0 ug/L AL	1.0 ug/L	10 ug/L	1.0 ug/L AL
Glen Ewen	76% (2-14 ug/L)	76% (2-14 ug/L)	1% (14 ug/L)	76% (2-14 ug/L)
Coulter	90% (2-17 ug/L)	90% (2-17 ug/L)	3% (11-17 ug/L)	90% (2-17 ug/L)
Selenium	0.001 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L
Glen Ewen	6.7%(0.002-0.0034 mg/L)	0	0	0
Coulter	2% (0.0015-0.002 mg/L)	0	0	0

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Initial Environmental Evaluation

TABLE: 6.9 Continued

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

Parameter	CCREM Guidelines	Saskatchewan Objectives	North Dakota Standards	Manitoba Objectives
Sodium	SAR 2-102 IR	30-70% cations	60% cations	6 SAR (IR) 60% cations
Glen Ewen				
Sulphate	500 mg/L DW	500 mg/L	450 mg/L	250 mg/L
Glen Ewen	4.8% (521-814 mg/L)	4.8 (521-814 mg/L)	9% (454-814 mg/L)	37% (251-814 mg/L)
Coulter	4.5% (510-1095 mg/L)	4.5 (810-1095 mg/L)	6% (452-1095 mg/L)	26% (251-1095 mg/L)
Sulphide	0.05 mg/L	0.01 mg/L		
Glen Ewen	0	0		
Coulter	0	0		
Total Dissolved Solids	500 mg/L	700 mg/L IR		500 mg/L DW
Glen Ewen	84% (518-2095 mg/L)	64.5% (706-2095 mg/L)		84% (518-2095 mg/L)
Coulter	82% (503-1588 mg/L)	40.5% (701-1588 mg/L)		82% (503-1588 mg/L)
Total PCB	1.0 ng/L AL	1.0 ng/L AL	0.14 ug/L	0.014 ug/L
Glen Ewen	0	0	0	0
Coulter	0	0	0	0
2,4-D	4.0 ug/L DW	4.0 ug/L AL		0.1 mg/L DW
Glen Ewen	0	0		0
Coulter	0	0		0
2,4,5-T	0.01 mg/L DW			0.01 mg/L DW
Glen Ewen	0			0
Coulter	0			0
Vanadium	0.1-1.0 mg/L IR	0.1 mg/L LW		0.1 mg/L
Glen Ewen	0	0		0
Coulter	0	0		0
Zinc	0.03 mg/L AL	0.05 mg/L AL	1.0 mg/L	0.047 mg/L
Glen Ewen	2% (0.049 mg/L)	0	0	2% (0.049 mg/L)
Coulter	1.6% (0.032 mg/L)	0	0	0

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DATE: July, 1989

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TABLE: 6.9 Continued

SOURCE: Environment Canada Conservation and Protection

6.2 Project Impacts

6.2.1 General

The greatest potential for impact on "international" water quality occurs when the flows are lowest in the Souris River. The 60 percent apportionment option would occur only when major flood peaks are recorded and Lake Darling has reached 485.24 m by October 1. Drawdown of the flood pool would normally occur over the summer months and occasionally into the winter. The 50:50 apportionment would be applied most of the time. The 50:50 option, with full irrigation of 4855 ha and cooling of the Shand Thermal Generating Station, has the potential for creating the most severe low flow conditions and greatest stress on water quality. Therefore, evaluation of Project impacts on water quality focusses on this scenario.

6.2.1.1 What Constitutes an Impact on Water Quality?

The quality of water crossing either international boundary must be such as to meet the requirements of the Boundary Waters Treaty of 1909. This Treaty does not, however, establish specific criteria by which achievements, measured against the requirements of Article IV, can be assessed. Under Article IV of the Boundary Waters Treaty of 1909, it is stated that:

> **"...boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other."**

The Project would not be contributing any pollutants per se to the Souris River, however, this additional flow regulation would result in the alteration of certain chemical and biological attributes. Alterations in water quality that affect authorized water uses would be considered injurious unless accepted under agreement and consent of the affected parties.

Water quality objectives do not exist for the international boundaries of the Souris River. Therefore, in their absence, the suitability of water quality under Project conditions has been assessed by comparing water quality to:

a) Existing norms (seasonal and annual);
b) North Dakota State standards and Provincial objectives; and,
c) Canadian Water Quality Guidelines.

For most parameters, there is good agreement between these jurisdictional indicators of water quality. However, for other parameters, there is considerable disparity which can only be harmonized through studies and international negotiations. In the cases of disparity, this assessment has focussed on the most stringent number.

In order to understand the potential impact of the proposed Project on the quality of water within Saskatchewan, North Dakota and Manitoba, it is necessary to determine the quality of water at the international boundaries, which in turn requires considering the water quality of the reservoirs, mainstem and tributaries.

A basic premise of this evaluation is that the Project-related water quality impacts at the Saskatchewan-North Dakota boundary would be transmitted further downstream. Those attributes which are not predicted to impair water quality at the boundary, in most cases, are not expected to cause downstream problems. There are some exceptions relating to those parameters that may, singly or in combination, cause downstream alterations in water quality. For example, although the total nitrogen and phosphorus concentrations at the Saskatchewan-North Dakota boundary may be improved because of upstream reservoirs, the Lake Darling nitrogen:phosphorus ratio may be altered, resulting in changes to the biological community.

The discussion that follows is, therefore, focussed on the predicted water quality concerns that are unique to each jurisdiction but are of specific interest to Canada.

6.2.1.2 Factors Influencing Water Quality

There are key processes or factors inextricably linked to the Project that must be discussed in the context of how they would potentially impact water quality. The effect of some of these factors is evident in the existing quality of waters throughout the basin (Section 6.1). The following discussion, although not exhaustive, serves to set the stage for the identification of potential impacts.

Landuse and Diffuse Pollution Sources

Agriculture dominates throughout the basin as the major landuse activity. Agricultural runoff is frequently diffuse in nature but can, nonetheless, be an important determinant in the quality of receiving waters. This is becoming a major water quality management issue across North America and has merit for consideration, particularly in low relief areas such as the Souris River basin where runoff, following precipitation events and snowmelt, can stay in contact with the underlying soils for long periods of time.

Several livestock operations exist within the Souris River basin. Many of these operations are located immediately adjacent to the water courses and likely contribute to local water quality deterioration.

Irrigation has the potential to influence receiving water quality through return flows and consumptive use. Return flows can increase the nutrient and pesticide loading of the Souris River and its tributaries. In irrigated areas, sound agricultural management practices, including water conservation and appropriate pesticide application techniques, can help reduce the pollution potential of return flows.

Impoundments and Reservoirs

The morphological characteristics of reservoirs (depth, size, orientation to prevailing winds, and shoreline slope) are critical factors in determining water quality. The deeper the reservoir the greater the probability for thermal stratification. The development of a temperture gradient (thermocline) in a reservoir, as may occur during the warmest days of summer, can last from one day to several months depending on climatic factors. The hypolimnion (below the thermocline) can have different and usually poorer water quality than the water in the epilimnion (upper layer of water). For this reason, the location of the reservoir outlet can be very important in determining downstream water quality.

As will be discussed later, the water quality constituents of primary importance in reservoir discharges are dissolved oxygen, dissolved nitrogen, ammonia, pH, total dissolved solids, metals, phosphorus, and sometimes pesticides. The importance of the constituents depends on the uses to be made of the water and the sources of pollution that may affect the reservoir water quality.

The instream wildlife refuges in North Dakota present an interesting water management challenge. If they are operated only for the propagation of migratory birds, this may be at the expense of other downstream water users either because of reduced water availability or because of adverse effects on bacteriological and nutrient quality. Biologically productive waters may result in anoxic conditions and ammonia toxicity concerns in the outflowing waters. Conversely, wetlands can also act as biological filters by removing nutrients and pollutants from the water.

Aquatic vegetation removes nutrients such as phosphorus and nitrogen during the summer growth period. Trace elements are also taken up by the roots. When the plants die in the fall, nutrients can be incorporated into sediments and removed from the downstream aquatic ecosystem, provided the sediments do not become resuspended in the water column and subject to transport, or become subject to forces of chemical and biological remobilization.

The Soil Factor

The creation of a reservoir essentially transforms a terrestrial environment into an aquatic ecosystem supporting entirely different chemical and biological processes. Newly flooded soils release nutrients, primarily due to decay of organic materials present in the soils and to dissolution. Upsurge (rapid release) of nutrients, salts, metals and pesticides could occur. The rapid release of such substances from an inundated area is expected to be of short term duration. However, microbial and other processes would continue over the long term.

The impacts associated with flooding cultivated and uncultivated land would differ. Upsurge of constituents from recently cultivated land would likely exceed the rate of upsurge from uncultivated (pasture) land. However, over the long term, the higher organic content of uncultivated land may provide for greater contribution of some constituents such as mercury. The potential for methylation of mercury is generally considered to be highest from flooded soils high in organic content. Under reducing conditions, mercury would be methylated leading to biomagnification through the foodchain.

Reservoirs become repositories for sediments transported from upstream. Normally these sediments would be transported downstream and deposited in quiescent reaches of the river or in lakes.

Because of the nature of their operation, some reservoirs may take years or decades to reach some degree of stability in terms of shoreline erosion and water quality characteristics. Successional shoreline erosion would produce additional sediments on an incremental basis directly linked to fluctuating water levels. Microbial processes, acting under a reducing or oxidizing environment would readily breakdown and transform dissolved and suspended matter.

The Flow Factor

The flow of the Souris River is a dominant factor affecting water quality. Generally, reduced flows can result in deteriorated water quality, particularly for such characteristics as biomass, dissolved gases (oxygen and ammonia) and dissolved salts. Low flows favour naturally occurring biological communities that respond to shallower water (e.g. macrophytes), higher temperatures and greater nutrient availability. Fish are among the first to suffer with low flows and move to more favourable habitat conditions when river or lake levels and water quality permit.

A river's assimilative capacity (ability to dilute or absorb a pollutant) is reduced under low flow, compounding options for pollution control and necessitating scheduling of sewage and other waste discharges to coincide with higher flows. Rivers with a sustained base flow typically have a higher proportion of ground water to surface water during low flow periods than under higher flows. Under these circumstances, the salt content usually increases markedly.

Rivers such as the Souris, which have a long history of extreme flows varying from no flow to high flood levels, support a rich adaptable biological community. Induced flow variations within certain ranges may not necessarily result in altering the biological diversity or community structure of the stream. However, should the periodicity of replenishing flows be significantly modified, species diversity could be affected.

Increased flows generally result in increased cleansing of the river channels (abrasive action), increased aeration and an enhanced aesthetic quality. Water derived from overland runoff following a major precipitation event would contain more erosional materials and land-based pollutants than runoff resulting from snowmelt. As noted above, the contact time between runoff and the land dictates the water quality. The salt content of extreme high flow events is generally low for most salts because of the dilution factor and short contact time. For reservoirs, this better quality water may determine the ultimate fate of quality in the reservoir and the quality of water downstream. In the Souris River more than 82 percent of the annual flow at Estevan can occur during a three-month period from April to June.

The Climatic Factor

In the Souris River basin, evaporation far exceeds precipitation in most years resulting in the concentration of chemical constituents in surface waters. The large open surface areas of reservoirs enhance evaporation relative to natural river channels. The concentrating effect would be less important for those reservoirs that have relatively short retention times or low surface to volume ratios. Evaporation rates can be increased by forced evaporation as in the case of cooling water discharges to Boundary Reservoir. Evaporation is one of the most important elements in the water balance of prairie reservoirs.

6.2.2 Saskatchewan

6.2.2.1 Reservoirs

According to the draft Operating plan, Rafferty Reservoir would in the long term normally discharge only to supply water for irrigation and cooling of the Shand Thermal Generating Station, unless it is being drawn down to accommodate a predicted flood. During filling, there would be few, if any, releases from Rafferty. It is understood that releases from Rafferty would not be a significant factor in meeting international apportionment obligations. Prolonged dry cycles would also have profound effects on the quality of water retained in the Reservoir. These facts have consequences for the quality and uses of Rafferty Reservoir.

The operation of both proposed Reservoirs would dictate the quality of water delivered to downstream reaches of the Souris River. On the basis of water quality attributes (these are discussed below), water releases from Alameda would provide water management flexibility from two points of view. First, its quality would be superior to the traditional water quality of the Souris River in virtually all respects. Second, an option would exist for Saskatchewan to use Alameda releases to dilute poor quality releases from Rafferty Reservoir to avoid contravening North Dakota water quality standards. Poorer quality water in Rafferty Reservoir is predicted, but its effects can be minimized or prevented as discussed below. The influences of reservoir discharge on downstream water quality are considered in Sections 6.2.2. to 6.2.4.

Dissolved Solids

A 100-year salinity or TDS trend was determined for the Rafferty Reservoir, using historical flow data for the period 1912 to 1981, primarily to assess quality of Reservoir discharge and the resulting implications for water quality at the two international boundaries. The principal assumptions of the trend model and resulting analyses were:

a) Rafferty Reservoir was in place in 1912 and the reservoir began to fill that year. Trends were calculated from hydrologic data collected from 1912 to 1981. For the period 1982 to 2011, the data set was re-entered beginning once again with 1912 data.

b) The TDS of inflowing water was computed as a flow-weighted concentration on the basis of TDS data from Glen Ewen (1982-1988) and was set at 345 mg/L (N = 76).

c) Consumption was calculated monthly and included irrigation, upstream uses and cooling water for the Shand Thermal Generating Station.

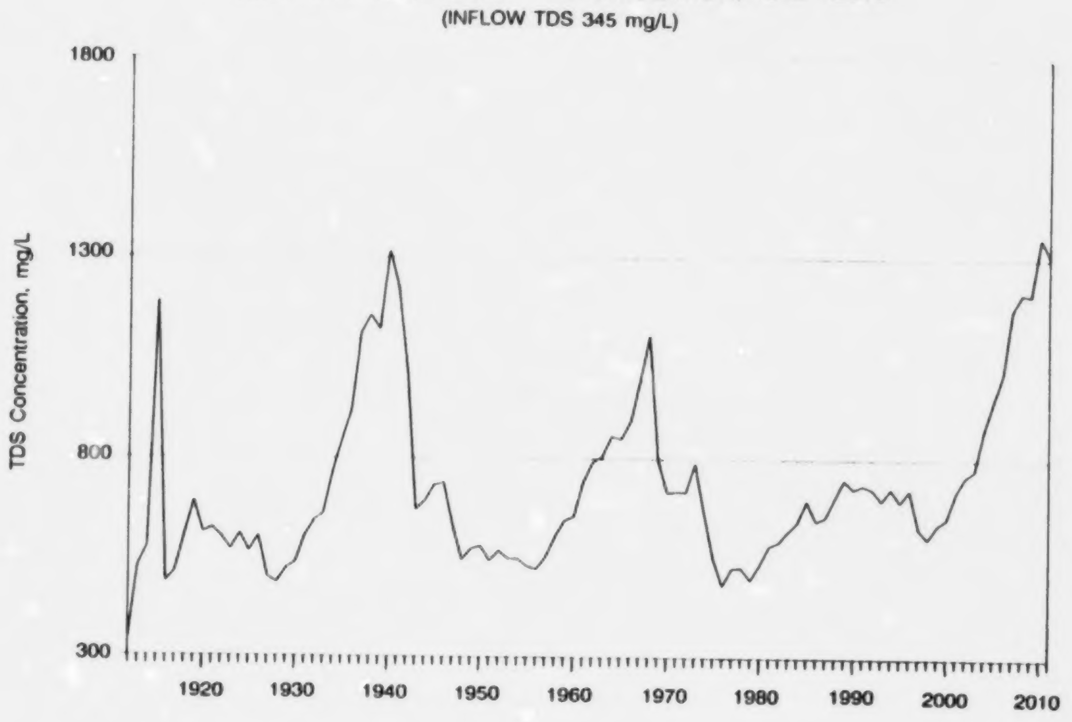
d) Annual inflows in excess of FSL were predicted, and an equivalent volume was discharged in late winter before the spring runoff began.

e) Evaporation was calculated as net evaporation multiplied by reservoir surface area.

The TDS of Rafferty Reservoir would have more than tripled (in the worst of years) had it started to fill in 1912 with water having a flow-weighted TDS concentration of 345 mg/L. A maximum of approximately 1300 mg/L would have been recorded in the late 1930s with some constituents exceeding the Canadian Water Quality Guidelines (CCREM 1987). For example, the TDS guidelines of 500 mg/L for drinking water and 800 mg/L for irrigation of a number of vegetable crops would have been exceeded. The Saskatchewan Municipal Drinking Water Quality Objective (Saskatchewan Environment 1980) for TDS is 1500 mg/L and would not have been exceeded. By 1953, when FSL would have been first attained, the TDS level would have readjusted to 545 mg/L. By 1988, the concentration would have increased to 704 mg/L. Years with low TDS values coincide with high flows and the reservoir near FSL; years with high TDS coincide with low flows and low water levels in the Reservoir (Figures 6.5 and 6.6).

Water quality in the Rafferty Reservoir would be suitable, on average and over the long term (according to Saskatchewan Water Quality Objectives), for municipal water supply and most agricultural uses, such as irrigation for wheat, barley and certain forage crops, and for livestock watering.

For purposes of comparison, Boundary Reservoir had a June to August 1982 TDS concentration of about 400 mg/L, and in 1988, the July concentration


RAFFERTY RESERVOIR - TDS SIMULATION, 1912 - 2010
(INFLOW TDS 345 mg/L)

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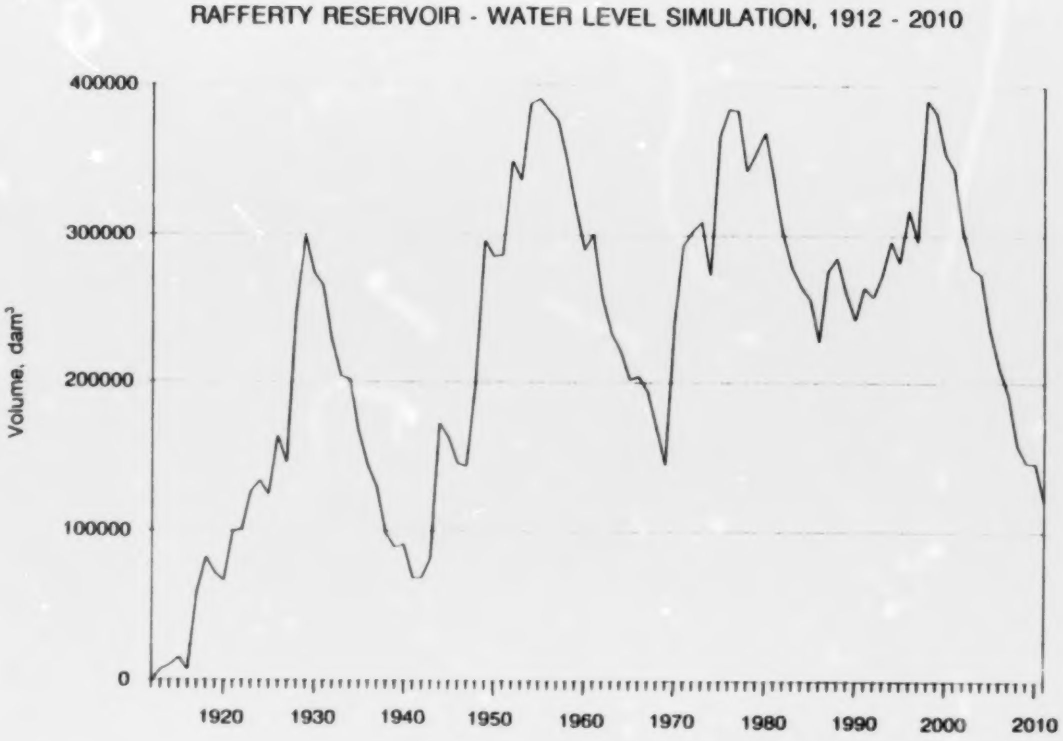
Rafferty - Alameda Project
Initial Environmental Evaluation

FIGURE: 6.5 Rafferty TDS Simulation 1912 - 2010

SOURCE: Environment Canada Conservation and Protection



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Initial Environmental Evaluation

FIGURE: 6.6 Rafferty Water Level Simulation 1912 - 2010

SOURCE: Environment Canada Conservation and Protection

was 1323 mg/L (approximately a three-fold increase). The higher 1988 level is thought to have occurred because of climatic conditions (evaporation), ash lagoon influences and ground water pumping into the Reservoir. For Cookson Reservoir (on the East Poplar River), TDS concentrations increased from about 350 mg/L in 1976 to a near steady state level of about 750 mg/L in 1985 (Poplar River Bilateral Monitoring Committee 1988). Neither Cookson nor Rafferty reservoirs receive or would receive ash lagoon wastes. Unlike Cookson, Rafferty would be more of a terminal lake until it reaches FSL, and even then, it would only discharge intermittently. Rafferty TDS would increase over time to a greater extent than Cookson Reservoir.

Alameda Reservoir would have about the same initializing TDS concentration as Rafferty Reservoir, but over the long term, it should be superior in quality due to the shorter retention time and greater depth.

The reservoirs would have a moderating effect on the quality of the Souris River and Moose Mountain Creek. The normal maximum observed in the low flow periods would be depressed because of the flow-weighting that the reservoirs achieve throughout the year. The net effect is little change to the mean annual dissolved solids concentrations but a significant reduction in the variance about the mean. In reality, the reservoirs would lower the downstream TDS concentration during the normal periods of low flow and slightly elevate the levels during spring releases, depending on the quality of the source water and the retention and mixing time in the reservoir.

Sulphate and Bicarbonate

The upper reaches of the Souris River above Rafferty Reservoir, and Moose Mountain Creek above Alameda, are classified as sulphate-type waters during low flow periods when the ground water quality influence is greatest (Table 6.7). During spring high flows, bicarbonates are slightly more abundant than sulphates. Of the total annual volume of water captured in the reservoirs, greater than 80 percent would originate from spring flows. Therefore, there would be a departure from existing conditions with sulphate-type waters below the reservoirs no longer prevalent during the fall and winter. There would be fewer winter exceedances of the Saskatchewan water quality sulphate objective.

Boron

Boron concentrations would be expected to increase by the same proportion as TDS. Should ground water augmentation of the reservoir either directly or indirectly be contemplated in the future, this would accelerate the increasing trend in dissolved constituents. Boron concentrations are predicted to reach a maximum of 1.2 mg/L from an initial concentration of 0.33 mg/L (median for the period of record as shown in Table 6.3). Exceedances of the Saskatchewan water quality objectives of 0.5 to 1.0 mg/L for sensitive crops (wheat and barley) would increase in frequency. Irrigation use of water is sensitive to increases in boron concentrations.

Levels at 2.0 to 4.0 mg/L would impair production of many common crops (Saskatchewan Environment and Public Safety 1988), but these levels are not predicted to occur in the reservoirs.

Pesticides

Irrigation associated with the Project involves about 6000 ha. There would be pesticide usage associated with this irrigation. Some pesticides may directly enter the Souris River as non-target impacts and others through runoff and irrigation return flow. The trend towards less toxic and more degradable pesticides (non-persistent), improved application guidelines and techniques and the high cost of pesticides, discourage misapplication and overuse of pesticides and consequently, less accumulation may occur in environmental compartments (sediment, water and biota). The location of the irrigable areas relative to the reservoirs and river, and the projected low irrigation return flow, support the view that an increased frequency in the detection of pesticides in the river environment would not be measurably different under Project conditions than what has been found historically and regionally.

It was noted during the Public Meetings that a pesticide container disposal site exists within the flooded area of Alameda Reservoir. This and other sites within the area that would be flooded by the reservoirs must be declared safe on the basis of thorough soil analysis before flooding is permitted. Soils which are found to be contaminated must be decontaminated or removed from the zone of reservoir influence.

Sedimentation

There is very little information concerning the amount of sediment carried by the Souris River. Sediments derived from upstream would settle out in existing impoundments and the reservoirs. This would create a sink in the reservoir for any pollutants that may be adsorbed to these sediments. However, this apparent benefit can be negated by anoxic conditions which may return these substances to the water column. Sedimentation in Rafferty and Alameda would benefit Lake Darling. Sedimentation loading to Rafferty could be higher than at Alameda Reservoir because Rafferty Reservoir captures about 28 percent of the natural flow originating in Saskatchewan portion of the basin as compared to Alameda which captures only 19 percent. Also, the shoreline of Rafferty Reservoir is predicted to be more unstable due to fluctuating water levels.

Upsurge of Salts, Metals, Nutrients and Pesticides

During the filling of the reservoirs, upsurge of chemical constituents from inundated soils would be an active process for many years. This would depend to some extent upon the preparation of the reservoir base prior to filling. Upsurge could release salts, nutrients, metals (iron, manganese and perhaps other heavy metals), and trace elements (e.g. boron) which may be within the soil. Upsurge of pesticides would not be expected as this effect has not been observed in either Cookson or Boundary Reservoirs.

Recent upsurge studies undertaken in the summer of 1989 by Environment Canada in association with M-R-2 McDonald Associates (for SBDA) conservatively estimate that salt, phosphorus and boron upsurge from soils of both reservoirs would be small in magnitude. The soils sampled represented three soil types in Rafferty and one in the Alameda reservoir area. For the samples tested, upsurge potentials for salts averaged about 34 percent and 16 percent for Alameda and Rafferty Reservoirs, respectively. This means, as a worst case condition, concentrations in the reservoir water may increase by this proportion over the long term. The upsurge potential of salts from the soils in the channelization area has been determined to be less than for the Rafferty Reservoir soils.

The short retention time of water in Alameda Reservoir would spread this effect over many years to the extent that the increase would not be distinguishable from the "concentrating effect" of evaporation. In Rafferty Reservoir where water retention is much longer, upsurge would be a shorter term phenomenon and a more significant factor in determining the TDS of the reservoir, although it too would likely be masked by the effects of evaporation.

It is apparent that soils subjected to past flooding vary in degrees of upsurge potential. Those which drain quickly (as in the steeper valley of Moose Mountain Creek) have the highest potential whereas those soils upon which the water has sat for extended periods of time and drained away slowly, have the lowest. In effect, soils in the Rafferty Reservoir area have been subjected to ongoing leaching during flood years to a greater extent that at the Alameda Reservoir location. The highest upsurge potential (156 percent) was observed in the dried impoundment areas above Dead Lake. These unusual soils constitute a minor fraction of the proposed flooded area.

As with most newly constructed reservoirs, there would be increased levels of mercury in the tissue of fish (see also Section 8). Within 10 years these levels should decline and stabilize, as in Cookson Reservoir, at levels within human consumption guidelines. Due to the higher acreage of cultivated land being flooded by Rafferty, mercury may be mobilized within a shorter time than at Alameda. The methylation of elemental mercury within the reservoirs has the potential to elevate the mercury tissue level of fish resident in downstream areas such as Lake Darling. However, if increases do occur, they would probably not be statistically significant. Dissolved mercury in the water column would continue at levels similar to existing (the analytical detection limit). Particulate mercury would be detectable because biomass is expected to be high and mercury is known to be bioaccumulated by aquatic organisms and adsorbed by particles. Recent soil analyses (McDonald and Hamilton 1989, Baweja _et_. _al_. 1989) suggest mercury values of <0.02 to 0.05 ug/g for soils in the two reservoir areas. These values are similar to background levels found for Cookson Reservoir (Waite *et al*. 1980).

Based upon data and information from other regional reservoirs and shallow lakes, concentrations of other heavy metals in biota are not expected to differ significantly from the long term norm.

Stratification

The maximum depth at full supply level of Rafferty Reservoir would be 15 m and for Alameda Reservoir it would be 35 m. Alameda Reservoir is more prone than Rafferty Reservoir to thermal stratification. Given the right climatic and hydrologic conditions, stratification is a possibility for both reservoirs. McDonald and Hamilton (1989) confirm this possibility. Should stratification occur, the quality of water in the hypolimnion would be impaired relative to the overlying water. Selective discharge (from the top or bottom) of this water from the reservoir provides an alternative for resource managers in meeting international water quality obligations. Such selective discharge would be intermittent, and when it does occur, no significant residual effect would be detectable in reservoir water quality.

Hypolimnetic discharges would impair quality in terms of dissolved oxygen, free ammonia, higher than normal iron and manganese, and at the source, the odour of rotten eggs (sulphides). Quality would probably recover in the stream within the Saskatchewan segment of the basin. Under ice and extreme conditions of low flow and high summer temperatures, the recovery zone may also include the river reach immediately downstream of the international boundary. This is thought to be a remote possibility and it could be prevented through appropriate operation of the reservoirs.

Nitrogen and Phosphorus

The SBDA has described the hypolimnetic water quality characteristics that could be encountered under a worst case situation. Data from eutrophic and hypereutrophic waterbodies were used to assemble this data base. SBDA's stochastic nutrient model projected that free ammonia from the reservoirs discharge could exceed the, then applicable, USEPA criterion of 0.02 mg/L during the August low flow period. Computer modelling by the USEPA has corraborated this and has further indicated that free ammonia exceedances could occur at a greater frequency and also during winter. Based on historical data for free ammonia in prairie lakes and the existing situation below Lake Darling and at the North Dakota-Manitoba boundary (Section 6.1), toxic levels of free ammonia would occur at a greater frequency if flows are reduced below normal during periods of high temperatures. Refinements have been made to the rate coefficients used in the ammonia model (McDonald and Hamilton 1989). According to these authors it appears that free ammonia in the Souris River at the Saskatchewan-North Dakota boundary is not as likely to be as significant a problem as originally thought although should exceedances occur, these would probably be during the late summer.

Given that the Rafferty discharge is predicted to be of poorer quality than Alameda, Rafferty releases may have to be scheduled with Alameda releases in order to ensure that downstream obligations (these are yet to be defined) are met, relying principally on dilution.

It is also expected that nitrogen and phosphorus conditions within the contained reservoir water would promote major algal blooms on the reservoirs. Rafferty is expected to proceed faster towards eutrophication than Alameda due to the difference in water retention time. Based on existing data for N:P ratios, the Souris River can be either nitrogen or phosphorus limited depending on the season and climatic conditions. The creation of the reservoirs may stabilize this ratio and cause a shift in the biological community.

With Saskatchewan withholding its entitlement under the 1959 Interim Measures, the annual loading of phosphorus and nitrogen should be reduced by almost 50 percent providing the current level of phosphorus and nitrogen remain the same. If the annual flow was reduced by 50 percent and the concentration doubled, this would effectively mean there would be no change in the annual loading relative to existing records. Since both phosphorus and total nitrogen concentrations are not predicted to increase as much as two-fold (McDonald and Hamilton 1988), annual loadings to Lake Darling under Project conditions are expected to be less than existing. This may not be true during the early years of reservoir operation when upsurge of nutrients and soil disturbance is most active. Any reduction in nutrients should be positive for the long term eutrophication prognosis of Lake Darling and downstream river reaches.

Ground Water Quality

Ground water can impact on the quality of transboundary surface waters, therefore implications resulting from changes in ground water flow or quality are worth noting.

The data from aquifers at the two reservoir sites show the ground water to be of relatively poor quality (in terms of salts, phosphorus and dissolved metals). The quality of water in either reservoir would be affected adversely by pumping ground water into the reservoirs. There is no proposal to augment reservoir supplies with ground water, therefore, implications of such action to downstream water quality have not been discussed. Clearly, should ground water pumping be a serious future option, a proposal would have to be developed and subjected to environmental impact assessment by proper authorities.

Within irrigation areas, salinization of receiving water bodies occurs when salts leached out of the shallow subsoil zone are transported by the leaching fraction via ground water flow to a discharge point, in this case, the Souris River. The attendant degradation of water quality in the receiving body would depend upon the amount of land to be irrigated, the size of the leaching fraction, the hydrogeology of the areas over which irrigation is to be practiced, the volume of water in the receiving body, and the retention time of water in the receiving water body. Such ground water contamination is not expected to be a major factor; however, the details and analysis upon which this conclusion should be based have not been provided by the Proponent.

Increased soil salinity due to ground water seepage downstream and around the Rafferty Dam is not of great interest from the federal viewpoint. These effects, while likely to occur, would not be observed at the international boundary. Because of the underlying geology, it is safe to say that the ground water effects of the Alameda Reservoir are not expected to be as great as those associated with the Rafferty Reservoir. For this reason, the effects on major aquifers at the boundary are expected to be insignificant.

Ground water implications to water quality due to excavation of the Rafferty-Boundary diversion channel, are expected to be local and not a transboundary concern.

In terms of water management, monitoring of major bedrock, buried valley, and intertill aquifers in the area between the Reservoir and connecting channel and the international boundary should be conducted over the long term. Detection of problems close to the Project site, such as lowering of ground water levels, degradation of water quality in the reservoirs due to diffusive movement of subsurface salts into the reservoir and irrigation return flow, would provide for advanced warning of problems and the opportunity for corrective action.

Biology

On the basis of the Canadian Water Quality Guidelines (CCREM 1987) for aquatic life, Alameda Reservoir quality would have good potential for supporting a sport fishery (Section 7) maintained through stocking efforts. Winterkill of fish would be an infrequent problem in Alameda Reservoir. Should Alameda have a steady release to the Souris River, there would also be the opportunity for a fishery downstream of the dam.

It is expected that Rafferty Reservoir would support a fishery, although due to its shallow nature, fluctuating water levels and impaired water quality, it would experience more fish kills than Alameda. Major winter fish kills would be anticipated during low water years. Algal blooms would be highly probable with the early years of reservoir operation possibly experiencing more intense growths. This would be in response to the incoming nutrient load and the predicted nutrient upsurge. Over time, it is expected that the aquatic community would be typified by eutrophic-dominated species similar to those found in Lake Darling and Boundary Reservoir. The biological community would be subject to ongoing stresses caused by water level variations and periods of anoxia.

6.2.2.2 Souris River and Moose Mountain Creek

The Saskatchewan portion of the Souris River considered here is the portion (approximately 100 km) between Rafferty and the international boundary. It includes the proposed 16 km channelization segment. Moose Mountain Creek refers to only that portion below Alameda Reservoir (approximately 4 km) to its confluence with the Souris River. The flows of the Souris River under Project operation would differ from historical conditions. Water quality could be expected to improve for a few parameters because of Rafferty Reservoir. The Reservoir would reduce the suspended sediment load by trapping sediments behind the dam along with contaminants and nutrients bound to the particles. The channelizing of the river below the Reservoir may temporarily offset this reduction.

Aquatic habitat quality in the Souris River and Moose Mountain Creek below the reservoirs should improve because of the moderating effect reservoirs have on the extremes in water quality. Irrigation and apportionment requirements would maintain channel flow in these reaches during the summer months. Flows at the international boundary would have increased by up to 3 m^3/s in 27 of 63 years and between 3 and 20 m^3/s in 8 of 63 years in the month of June, had the Project been in place during 1912 to 1974. Flow increases in July to September would have been realized in 10 to 12 years during this period. Enhanced dissolved oxygen conditions over historical should be realized with these flow increases. Weirs built to supply water for irrigation would also provide suitable wintering habitat for a variety of aquatic species. On the precautionary side, flow augmentation during summer periods could give fish a false sense of wintering security. If river pools or weir impoundments become stagnant over winter, fish would be winterkilled. In moderate to wet years, flows are expected to continue through the winter period. This would depend on the antecedent storage conditions.

In late winter of any year should spring flood conditions be predicted, water would be released from the major reservoirs possibly as early as the first week of February. These releases would occur much earlier and would be more saline than the natural spring snowmelt flood event. The implications of this unnatural winter release for aquatic life forms remains speculative. The winter biological community structure downstream would be severely changed when such would releases occur, returning to more normal conditions as spring flows (albeit reduced) move through the basin. If reservoir water were to become anoxic over winter (this would be variable from year-to-year) some aquatic life forms including fish could be killed below the dams, possibly for several tens of kilometres.

Significant flow reductions would occur in all months according to the latest computer simulations. Under Project conditions from 1912 to 1974, flow reductions in the month of October relative to the simulated historical data base, would occur in 59 of 63 years. Under normal circumstances these reductions would have negatively impacted the quality of the Souris River. However, with the Estevan sewage effluent diverted for cooling water use at the Shand Thermal Generating Station, the quality of water would probably improve in this reach. If Boundary Reservoir is used to meet apportionment obligations, its quality would have to be taken into consideration (see discussion on dissolved solids).

Predictions using a worst case scenario currently indicate that the quality of the Souris River below Rafferty to just above the international boundary could potentially suffer increased free ammonia concentrations and low dissolved oxygen (Zander 1988, McDonald and Hamilton 1988, and 1989). The irrigation weirs (twelve proposed) could enhance the aeration of the Souris River, mitigating otherwise low dissolved oxygen.

The dredging and channelization below Rafferty Reservoir would have temporary impacts on the Souris River. The increased turbidity can be expected to cause destabilization of the downstream biological community and increases in particulate phosphorus and organic nitrogen. This would last as long as it takes for this reach to stabilize or be flushed by high flows. Although the USEPA has suggested that there may be increased leaching of salts from the newly exposed river bed or from dredge spoils, this too would be temporary and could be minimized through appropriate management practices. These effects, if not masked by instream quality, would be undetectable once mixed with Alameda Reservoir and Lake Darling waters.

The quality of Moose Mountain Creek below the Reservoir is not expected to be altered significantly from existing conditions, except for perhaps some damping of the extremes in dissolved constituents due to regulated flow. Waters below the Dam would be bicarbonate throughout the entire year rather than alternating between sulphate and bicarbonate. Suspended sediment derived from upstream areas would be trapped within the reservoir. The augmentation of normally low flow periods could result in increased channel erosion below the Reservoir but this is not thought to be significant enough to warrant a water quality concern.

6.2.3 North Dakota

6.2.3.1 International Boundary to Lake Darling

Historically, monthly zero flow situations in the international boundary waters (Sherwood) have been recorded between 17 and 34 percent of the time for the period September to March (Figure 6.7). Increases in water shortages, rather than decreases in flooding, would have the greatest impact on water quality. The U.S. Army Corps of Engineers has indicated

ZERO FLOW FREQUENCY DISTRIBUTION FOR SOURIS RIVER AT SHERWOOD,
1931 - 1987
(WITH % DURATION)

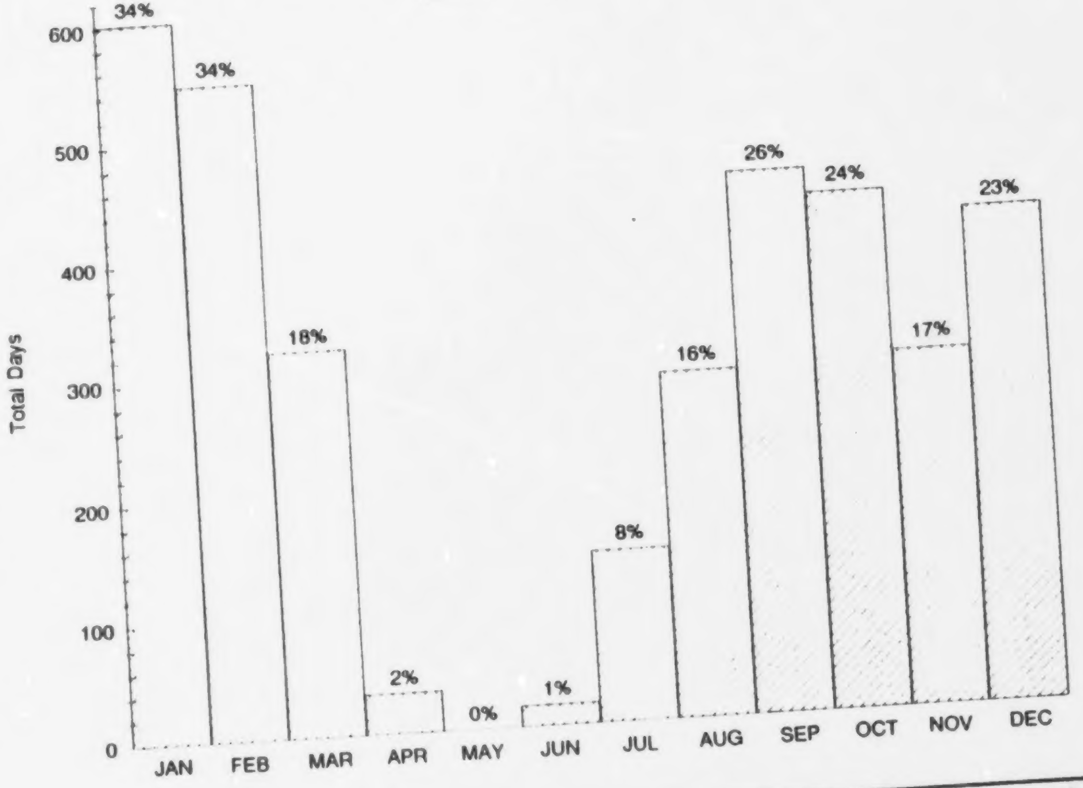

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FIGURE: 6.7 Zero Flow Frequency Distribution at Sherwood

SOURCE: Environment Canada Conservation and Protection

that 75 to 90 years out of 100 there would be water shortages in Lake Darling. Should these shortages occur before a dry spring, there would be severe water quality consequences for Lake Darling, especially its fishery.

Except for the month of October, Rafferty and Alameda reservoirs would not have made any difference to the flows recorded at Sherwood during extreme dry periods such as in 1937 (Figure 6.8a-d). Therefore, the Project would not provide much opportunity (under the proposed operating plan) to improve upon the low flow conditions experienced on the Souris River during dry years except when a wet year immediately proceeds the dry year. Modelling has indicated that the zero flow may occur three percent of the time less often than with the simulated historical data base (Section 5). Simulated post-Project average flow years (1922 and 1965) indicate that flows would be reduced relative to the historically recorded flows. During high flow years such as 1955, the post-Project flows would be lower in April, May and June with higher (and a benefit to water quality) than simulated historical flows in the months of July, August, September, November and December (Figure 6.8c).

The number of years during which monthly flow increases or decreases would have occurred had the Project been in place between 1912 and 1974 are shown in Table 6.10. Increases in most months would have occurred in 2 to 13 years out of 63. The months of February, March, June, November and December would have had increases in 17 to 29 years out of 63. Clearly, water quality improvements on account of increased river flow would be the exception not the rule.

Large volume discharges from Rafferty would be infrequent and would occur only before an expected flood event. Water from Rafferty and Alameda reservoirs would mix at the junction of Moose Mountain Creek and the Souris River, and overall quality should improve relative to Rafferty Reservoir water.

The median TDS for the Alameda Reservoir should be about 353 mg/L. Under normal operating conditions, about 6000 dam³/year would be discharged from the Rafferty Reservoir, however, most of this would be used for irrigation. Data from the 100 year trend analysis (Figure 6.5) suggest that Rafferty Reservoir TDS concentrationsin excess of 800 mg/L would have been a frequent occurrence during 1935 to 1942 and 1963 to 1968. Sufficient water would be available in the Alameda Reservoir to reduce TDS levels in the Souris River coming from Rafferty to below the Canadian water quality irrigation guideline of 800 mg/L (for vegetable crops). A 2 to 1 mix of Alameda to Rafferty releases would occasionally be required to meet this guideline.

The draft operating plan for Rafferty Reservoir indicates that in years when significant flood-flows are predicted, the reservoir discharge would begin in early February. In these years, there is unlikely to be significant runoff before early April. Thus, a substantial volume of relatively poor quality water could be released for up to two months. Releases into

PROJECT INDUCED FLOW CHANGES

DECREASES

Flow:	0–0.5	0.5–1	1–3	3–5	5–10	10–20	20	Total
Jan	39	0	0	0	0	0	0	39
Feb	39	0	0	0	0	0	0	39
Mar	15	9	10	1	1	1	0	37
Apr	10	2	5	6	8	11	10	52
May	19	5	7	3	6	3	6	49
Jun	6	6	5	3	2	2	0	24
Jul	24	8	7	0	3	0	1	43
Aug	26	2	1	0	0	0	0	29
Sep	25	0	0	0	0	0	0	25
Oct	56	3	0	0	0	0	0	59
Nov	26	1	0	0	0	0	0	27
Dec	19	0	0	0	0	0	0	19

INCREASES

Flow:	0–0.5	0.5–1	1–3	3–5	5–10	10–20	20	Total
Jan	13	0	0	0	0	0	0	13
Feb	17	0	0	0	0	0	0	17
Mar	18	2	2	0	0	0	0	22
Apr	3	0	0	0	0	0	0	3
May	6	4	1	2	0	0	0	13
Jun	6	7	14	2	4	2	0	35
Jul	4	0	1	0	2	2	0	9
Aug	8	1	1	0	1	1	0	12
Sep	8	2	0	0	0	0	0	10
Oct	1	0	1	0	0	0	0	2
Nov	19	0	0	0	0	0	0	19
Dec	26	2	1	0	0	0	0	29

Number of years in the period 1912–1974 when, under Project conditions, the monthly flows (m3/s) would have increased or decreased relative to simulated historic flows at the Saskatchewan–North Dakota boundary

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Initial Environmental Evaluation

TABLE: 6.10 Project Induced Flow Changes

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SOURIS RIVER AT SHERWOOD:
SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1922 (AVERAGE YEAR)
MEAN MONTHLY FLOW m^3/s, (50:50/IRRIGATION/START FILLING 1912)

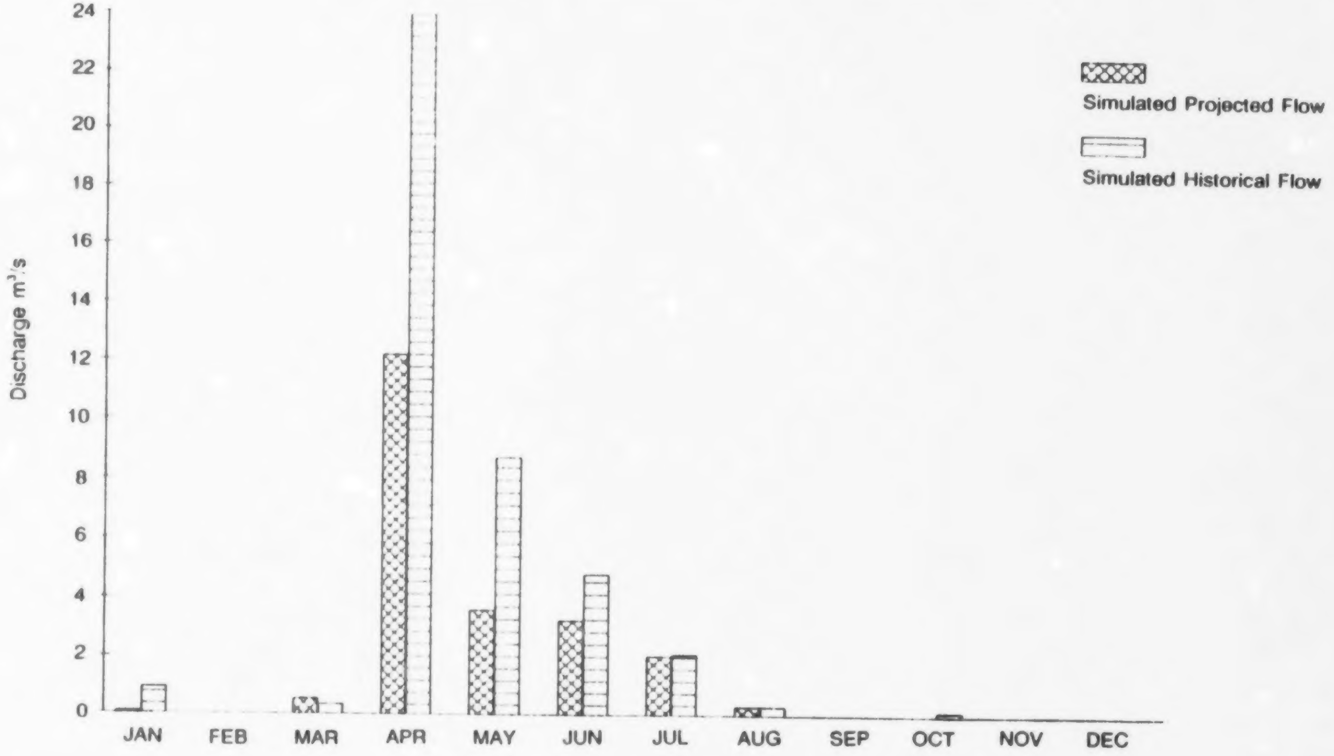

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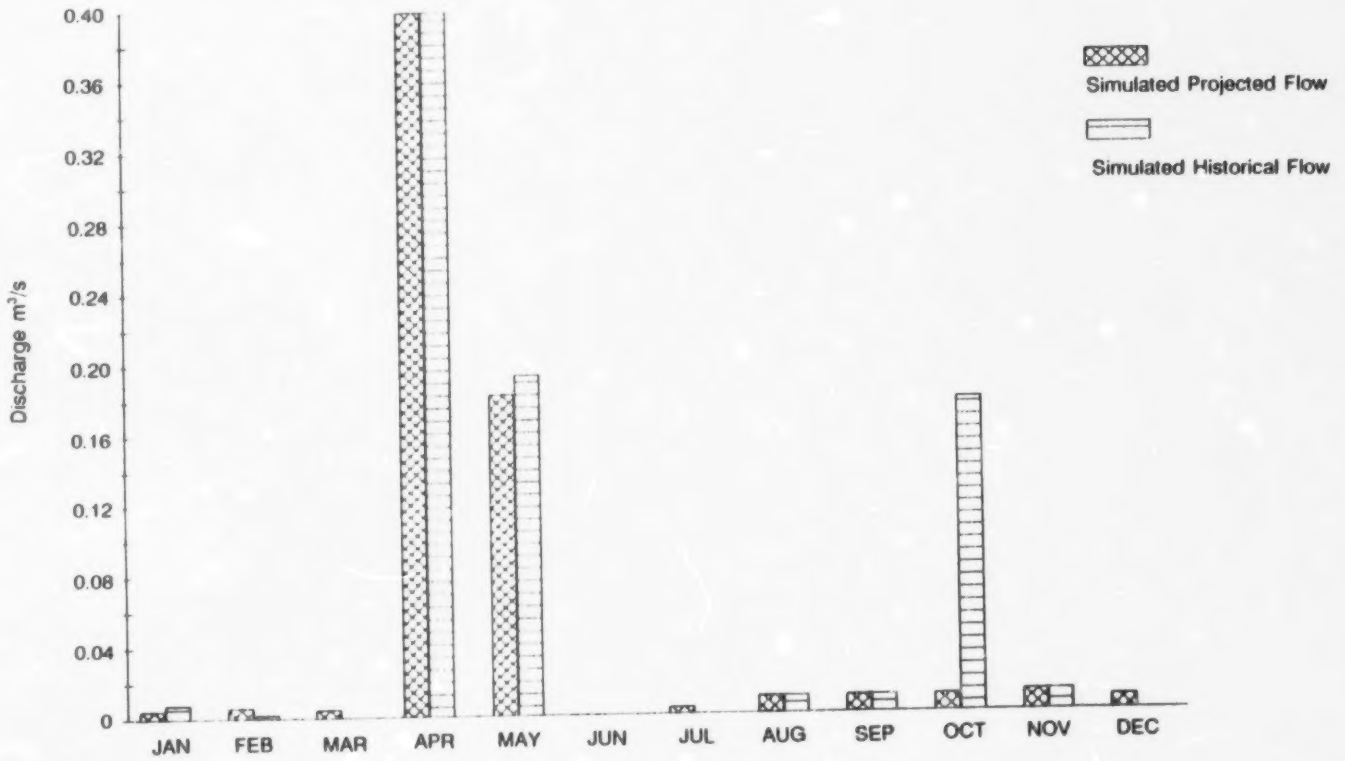
FIGURE: 6.8a

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SOURIS RIVER AT SHERWOOD:
SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1937 (DRY YEAR)
MEAN MONTHLY FLOW m³/s, (50:50/IRRIGATION/START FILLING 1912)



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Initial Environmental Evaluation

FIGURE: 6.8b

SOURCE: Environment Canada Conservation and Protection

SOURIS RIVER AT SHERWOOD:
SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1955 (WET YEAR)
MEAN MONTHLY FLOW m³/s, (50:50/IRRIGATION/START FILLING 1912)

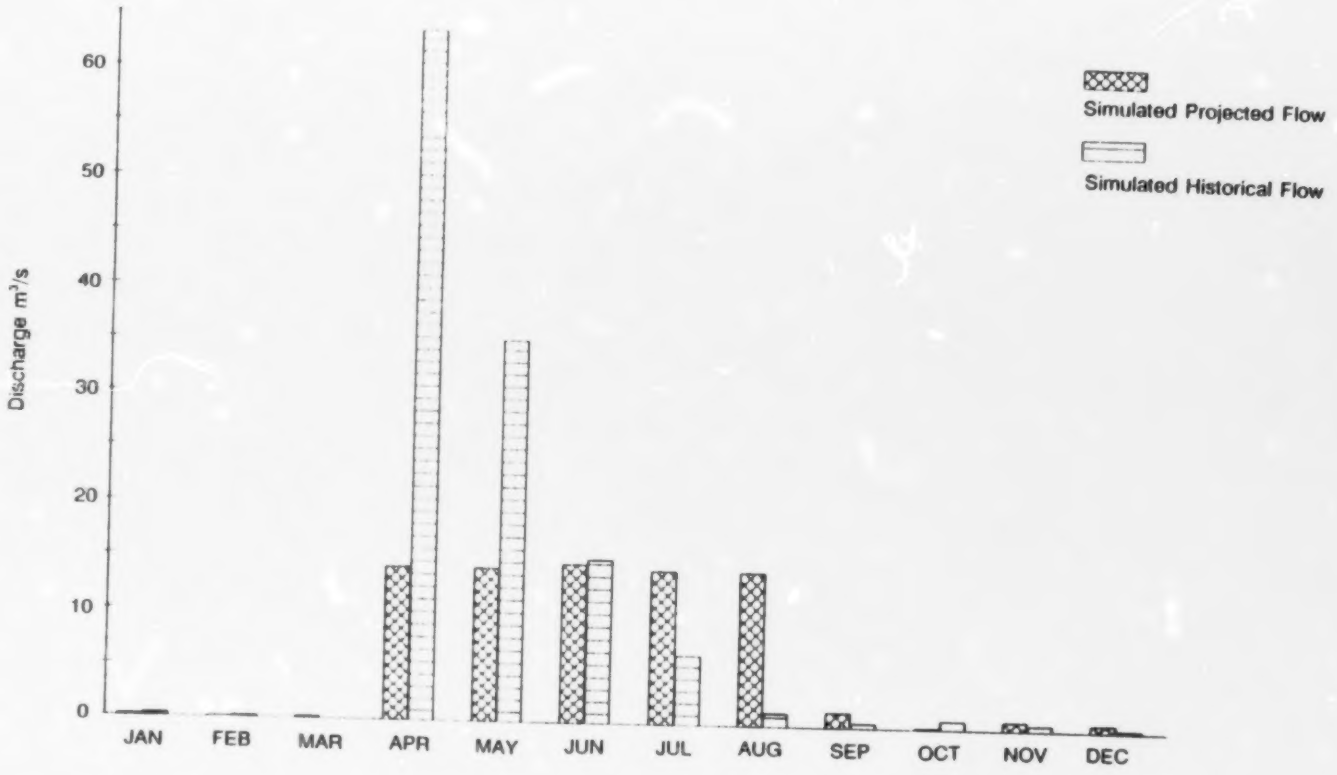

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FIGURE: 6.8c

SOURCE: Environment Canada Conservation and Protection

SOURIS RIVER AT SHERWOOD:

SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1965 (AVERAGE YEAR)
MEAN MONTHLY FLOW m³/s, (50:50/IRRIGATION/START FILLING 1912)

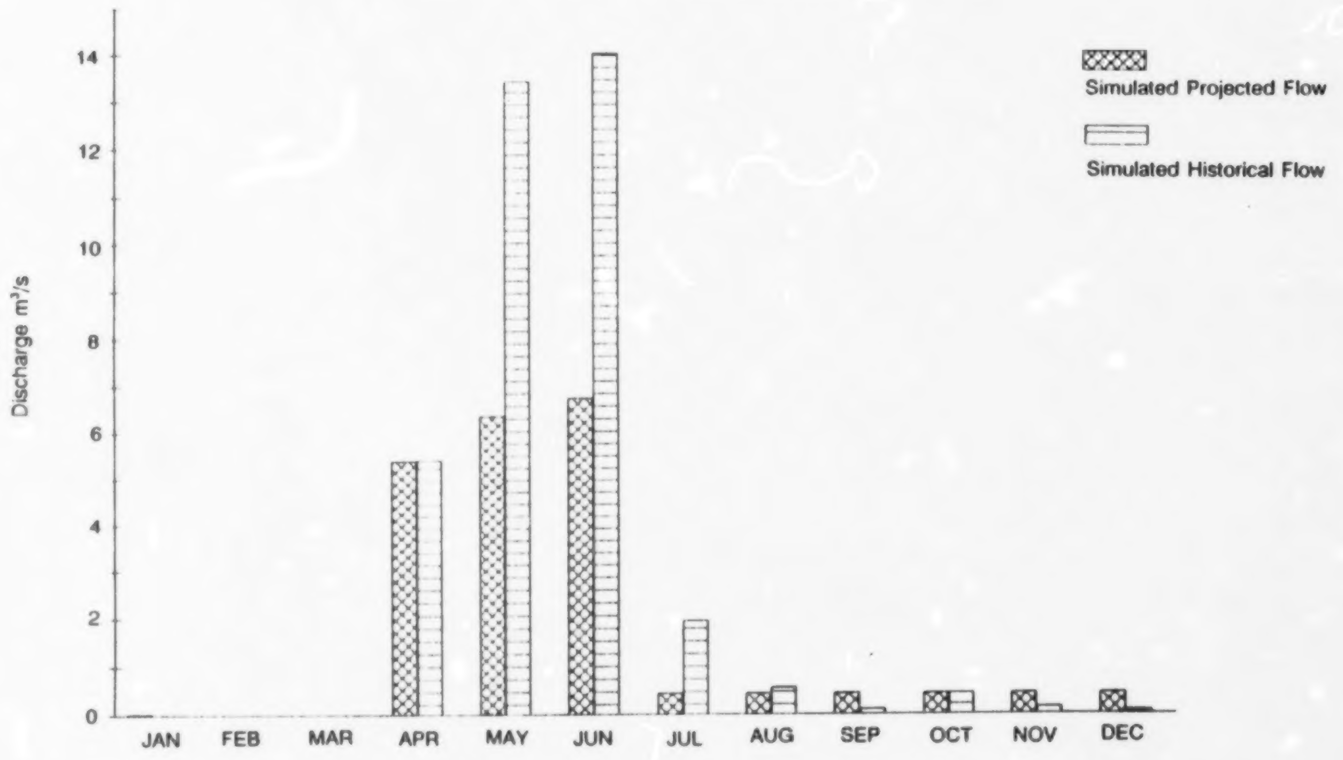

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FIGURE: 6.8d

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

the Souris River would occur under ice and without the benefit of aeration and dilution from runoff within the basin. This water could be high in organic carbon, low in oxygen and contain higher than normal free ammonia, total dissolved solids, boron, dissolved phosphorus and nitrogen.

The water uses within this reach of the Souris River would not be impaired unless the anoxic releases, which are possible in winter or late summer, fail to dissipate before reaching the boundary. Under such circumstances, aquatic life would be impacted. The water quality modelling carried out for the North Dakota-Saskatchewan boundary (McDonald and Hamilton 1988) was achieved in an international forum at which worst case conditions were tested. Further modelling and work was undertaken by SBDA and the results are included in supplemental reports to the SBDA EIS. The results of the investigations indicate that concentrations of dissolved oxygen, ammonia, phosphorus (total), algal biomass, TDS, boron, mercury and trace substances should not differ significantly from existing conditions. Early work by the SBDA (McDonald and Hamilton 1988), predicted that only during August, under the worst conditions and extreme probabilities, would ammonia exceed the 1988 North Dakota standard of 0.02 mg/L. The U.S. Environmental Protection Agency has predicted a worst case free ammonia condition of 0.3 mg/L during August or 0.15 mg/L if multiple outlets existed at both Canadian reservoirs. Exceedances were also predicted for June.

Lake Darling is a recipient of sediments transported across the international boundary. The proposed reservoirs would effectively trap sediments derived from the uppermost reaches of the Souris River basin, reducing the load to Lake Darling. The benefits of such would not be known for a long time, but they would possibly result in reduced phosphorus loading (a eutrophication concern), and reduced amount of sediment-transported pesticides. The existing sediment load would be substantially reduced once the effects of construction and channel work stabilized. This sediment reduction would help relieve an already existing problem of sedimentation in Lake Darling, which is projected to reduce storage capacity by 20 percent over the next 100 years.

The volume of water from Saskatchewan is the most significant factor affecting the uses on Lake Darling. The reduced spring flows would inevitably alter the flushing pattern and frequency of flushing that the lake has experienced since its construction. The local fisheries would be impaired and perhaps placed at risk. The U.S. Army Corps of Engineers EIS indicates that stocking of the lake would probably not be cost effective (Section 8).

Under Project conditions, the periods of greatest risk to the quality of Lake Darling would be when low water yields exist within the upper basin, and during the winters of virtually every year. Alameda Reservoir flows would constitute the majority of the waters crossing the boundary. Given the situation, the chemical quality of the waters crossing the international boundary would be within existing ranges for dissolved substances and possibly improved. However, the quality of Lake Darling may not have a corresponding improvement because of the counteracting effects of lower lake levels caused by decreased flow volumes.

6.2.3.2 Lower Souris River and J. Clark Salyer NWR

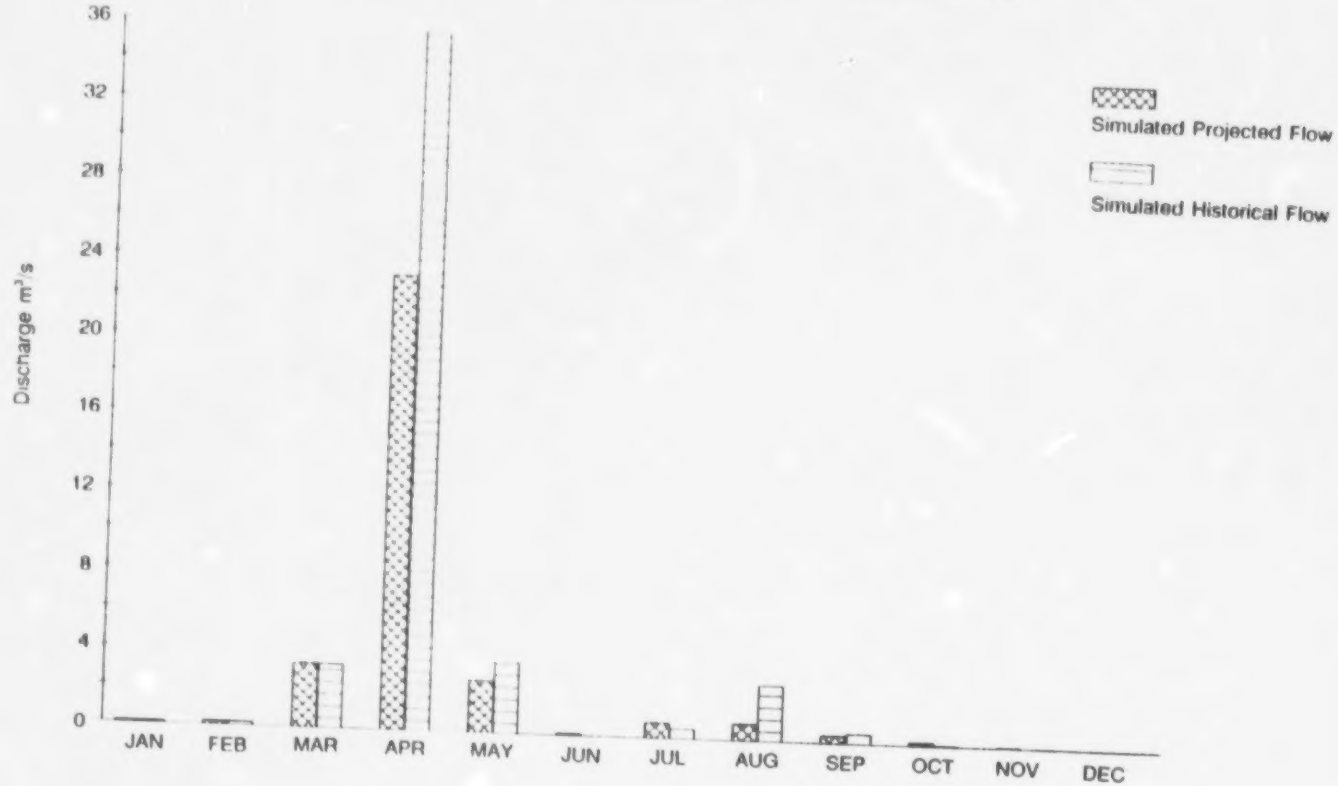
From Lake Darling to the Manitoba-North Dakota boundary, the quality of the Souris River would be dominantly controlled by releases from Lake Darling, municipal inputs and the influence of J. Clark Salyer NWR. The reduced quantity of flow resulting from the Project would resist the ability of North Dakota to manage the refuges, improve water quality and meet waterfowl management objectives. The direct water quality effects of the reservoirs would be attenuated by Lake Darling and instream processes. Manitoba obligations are most senior, coming ahead of all other uses in North Dakota. Releases from Lake Darling are then used to satisfy the senior water rights (J. Clark Salyer NWR and Eaton Irrigation District), followed by the city of Minot.

Following flood storage in Canada, there would be higher summer and fall flows (Figure 6.8c) released into North Dakota. In order to accommodate these, Lake Darling could be releasing higher than normal amounts of water downstream. During an average flow year (1922 and 1965), post-Project flow conditions below Lake Darling (e.g. Minot) over the winter months would be lower than normal unless a spring flood is predicted (Figure 6.9a,d). Dry year (1937) post-Project flows would remain unchanged (Figure 6.9b) with zero flows still being common in November and December.

Reduced flows from Lake Darling during the summer and winter months not only affect the amount of water received in J. Clark Salyer NWR, but also reduce the capacity of the river to recover from any effluents which may be discharging at the time. The U.S. model results indicate that water would be available in Lake Darling for diluting treated municipal discharges from city of Minot 30-40 percent of the years in the spring and 30-35 percent of the years in the fall. The U.S. Army Corps of Engineers has indicated that Minot intends to coordinate its releases more closely with the Lake Darling releases in order to meet its permit requirements. The parameters of increasing concern because of low flow would be dissolved solids, dissolved oxygen, free ammonia and bacteria.

The lower dilution ratio would increase the concentration of nutrients and other chemical substances, but overall, the instream loading should be reduced compared to historical observations. Any concentration concerns that arise (e.g. free ammonia) because of treated municipal water from the city of Minot, coupled with the incremental lower flows should be restricted to the reach below Minot and possibly the upper part of J. Clark Salyer NWR. It should be noted that the effects of Minot discharges have never been clearly discernible from other pollution sources, at the Manitoba boundary. The Minot treatment system has been significantly upgraded over the last 6 years. The long-term benefits of this upgrading would be offset to some extent by the Project-induced lower flows.

SOURIS RIVER AT MINOT:
SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1922 (AVERAGE YEAR)
MEAN MONTHLY FLOW m^3/s, (50:50/IRRIGATION/START FILLING 1912)



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DATE: July, 1989

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FIGURE: 6.9a

SOURCE: Environment Canada Conservation and Protection

SOURIS RIVER AT MINOT:
SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1937 (DRY YEAR)
MEAN MONTHLY FLOW m^3/s, (50:50/IRRIGATION/START FILLING 1912)

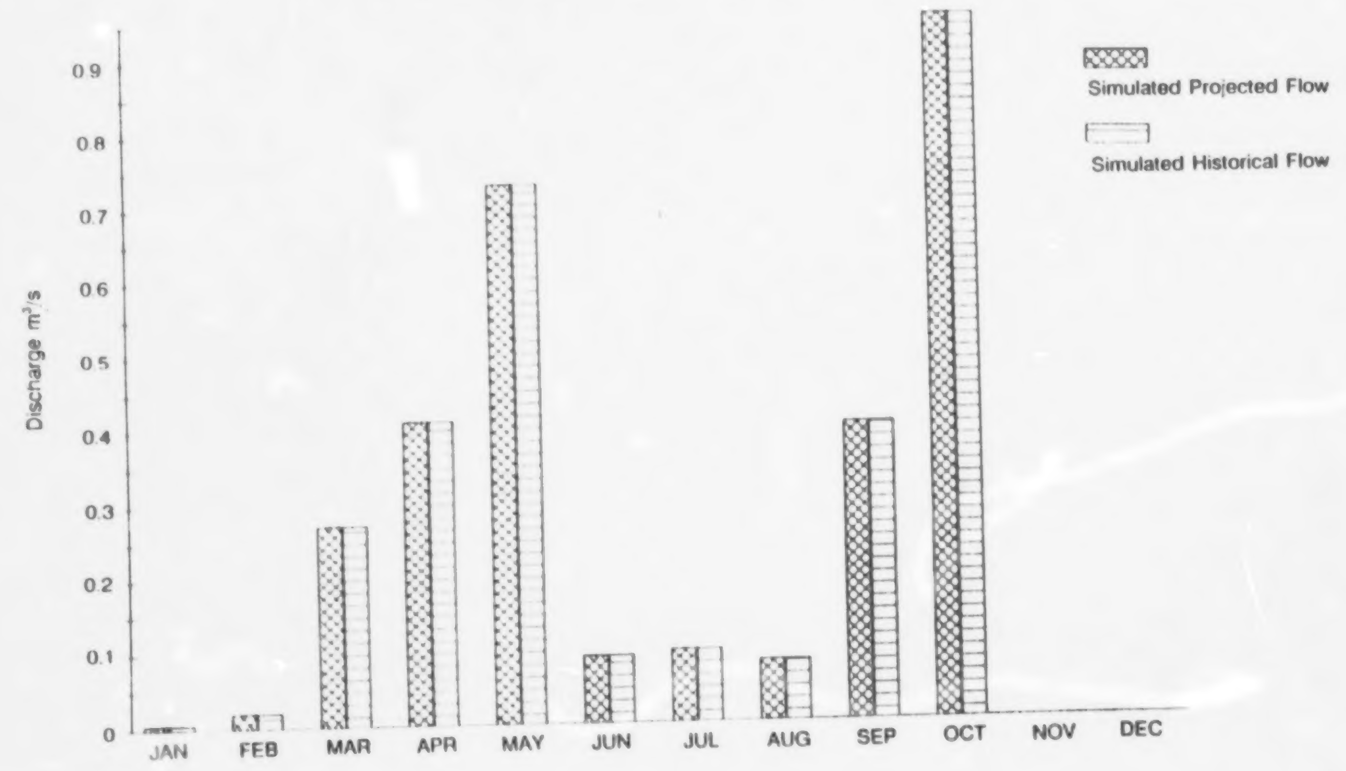

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FIGURE: 6.9b

SOURCE: Environment Canada Conservation and Protection

SOURIS RIVER AT MINOT:
SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1955 (WET YEAR)
MEAN MONTHLY FLOW m^3/s, (50:50/IRRIGATION/START FILLING 1912)

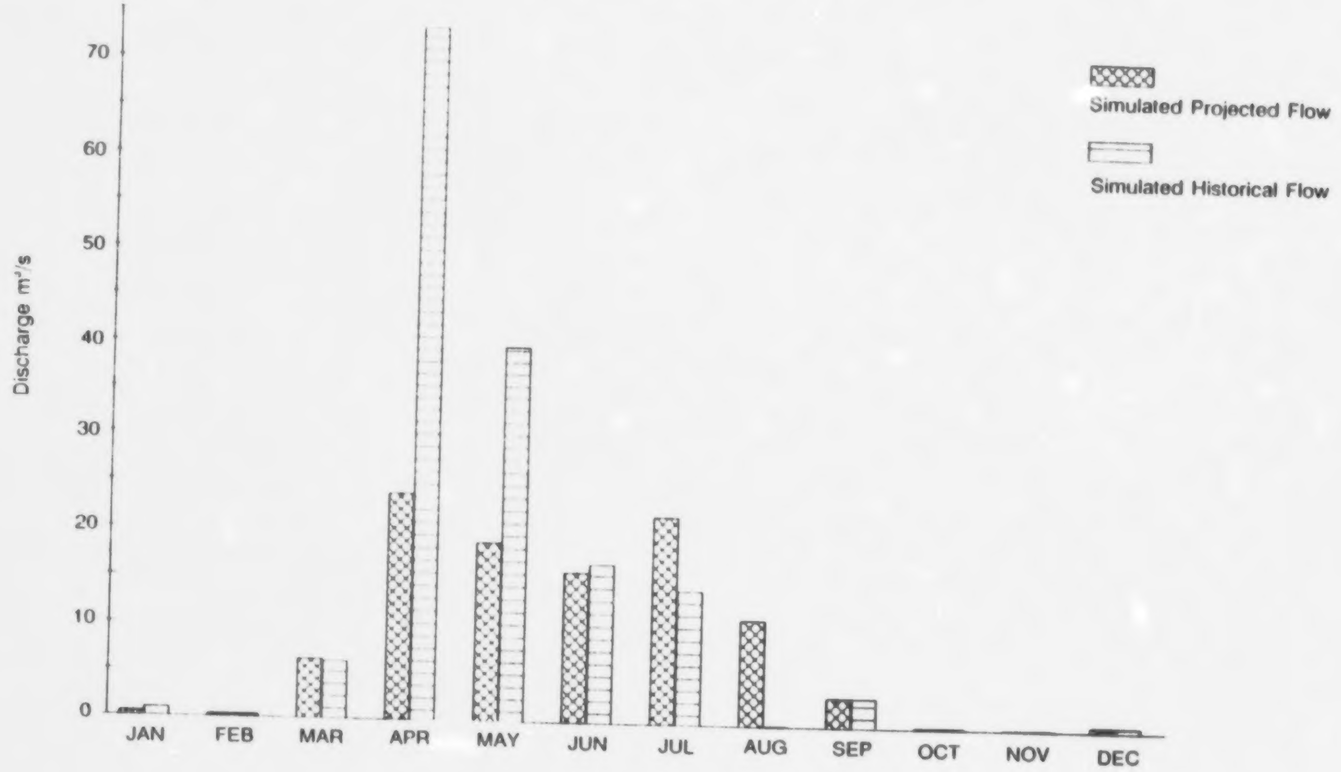

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FIGURE: 6.9c

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SOURIS RIVER AT MINOT:

SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1965 (AVERAGE YEAR)
MEAN MONTHLY FLOW m^3/s, (50:50/IRRIGATION/START FILLING 1912)

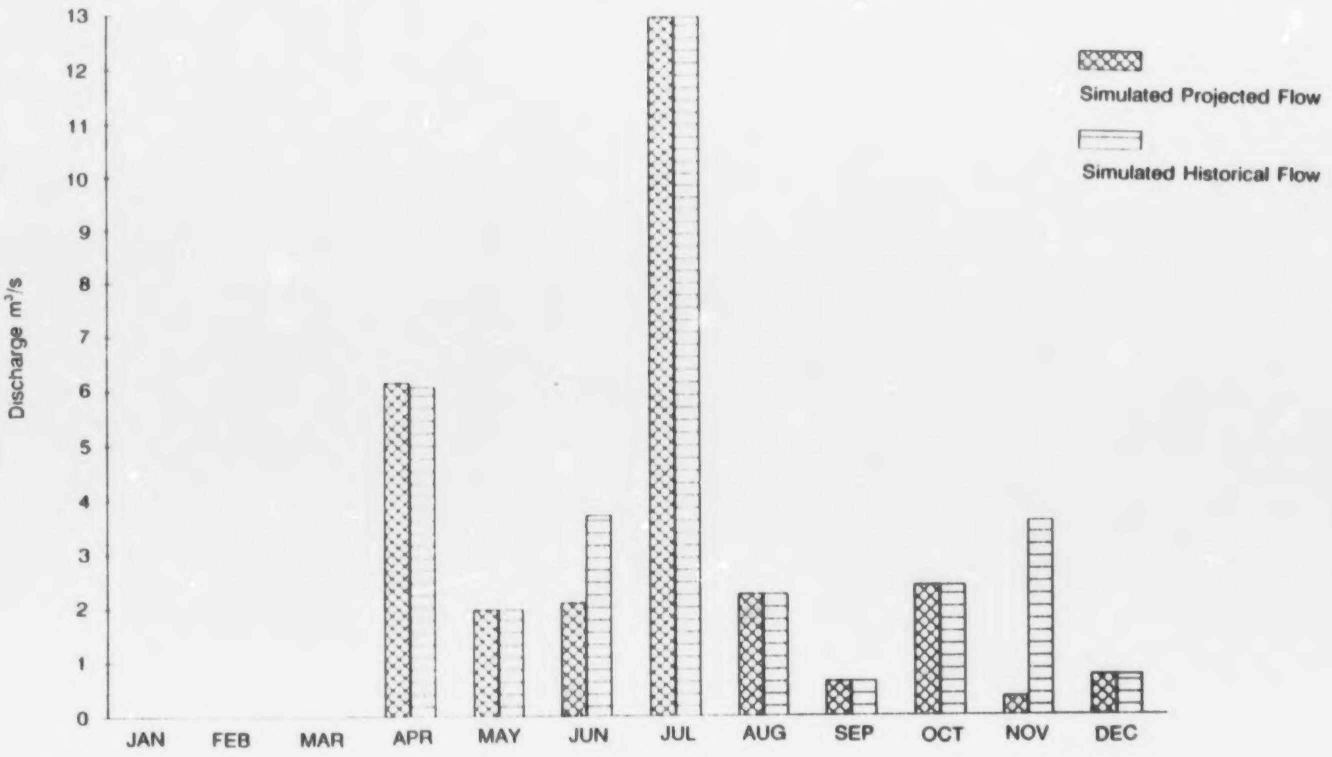

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FIGURE: 6.9d

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

The U.S. Fish and Wildlife Service considered the implications of low flow to the quality of water entering the refuge and the potential impacts on waterfowl and fisheries (U.S. Army Corps of Engineers 1988). They have projected that 6 out of every 10 years the Souris River between the two refuges could have no flow during periods outside of spring runoff except for local contributions. Further impairment to water quality and greater frequency of lower flows may exacerbate botulism disease outbreaks in waterfowl.

The transient spring and fall population of migratory birds can swell the resident refuge population by hundreds of thousands (Section 7.0). The impacts of the resident and the migratory populations on downstream water users include increased nutrients, decomposing organic matter, and reduced oxygen supply in and below the refuges. Domestic water users and livestock may be vulnerable to poor quality water flowing from such refuges.

It is apparent that the river reach in the United States between the two boundary crossings is a net producer of dissolved phosphorus and dissolved nitrogen. This is indicated by comparison of the dissolved phosphorus levels at the two international boundaries (Table 6.3). Saskatchewan-North Dakota (Glen Ewen) has a long-term average of 0.11 mg/L whereas at the North Dakota-Manitoba (Coulter) Boundary, the average is 0.215 mg/L. Under circumstances of higher flow in the summer months, dissolved concentrations could be increased due to flushing of J. Clark Salyer NWR.

6.2.4 Manitoba

Changes in water quality at the North Dakota-Manitoba boundary that might occur after Rafferty and Alameda are operational are not likely to be directly attributable to the Project itself due to almost 660 km of river between the reservoirs and Manitoba. The complex environmental processes that take place in streams, seasonally within lakes and between water, sediment and biota would mask the water quality attributes otherwise attributable to the water coming from Saskatchewan. The main concern to Manitoba is the collective effect of the Project and the United States works. Within this reach, there are two wildlife refuges and several major tributaries.

6.2.4.1 Water Quality-River Flow Relationship

A good appreciation of flow conditions is necessary in order to understand the potential water quality implications associated with the Project. For this reason, an analysis of flow, but with a water quality perspective, has been provided below. Flow into Manitoba would be reduced by as much as 48 percent with a 1912-74 average annual reduction of 20 percent. During the 63 year period of 1912 to 74 with the Project in place, "no change in the annual flow" would have occurred in 18 years. Annual flow reductions would have occurred in 45 (71 percent) years of this period.

The number of years in the period 1912-74 when, under Project conditions the monthly flows would have increased or decreased relative to simulated historic flows at the two international boundary crossings of the Souris River, are shown in Table 6.11. Figures 6.10a to 6.10d show existing and predicted flows for selected years of low (1937), average (1922 and 1965) and high flows (1955).

There are no existing scientific data from which flow criteria can be established to protect or enhance the biological and chemical quality of the Souris River in Manitoba. This could be reconciled by research or long term monitoring. Water quality can, therefore, only be predicted in general terms and within wide ranges of river flow. With higher than normal flows, especially during the summer and early fall, recreational and aesthetic quality of the river would be better than historical; lower than normal flows would generally result in worse quality than historical.

Low Flow Period

From a water quality perspective, the most critical period for Manitoba under Project conditions would be when lower than historical low flows would be received but still in compliance with apportionment requirements. It is hypothesized that flow increases during the summer period following high spring flows, (above historical levels) could result in a net improvement in the river quality. Such increases above the simulated historical flows during the critical low flow period of June to October (Table 6.11) is virtually non-existent except for a few years (8) when instream flows are higher anyway. Opportunities for flow enhancements from North Dakota would be less frequent than in the past because Saskatchewan would be using more water. North Dakota water users would, therefore, be placing a greater demand on waters originating within North Dakota.

Of the 32 years categorized as dry (that is, years with less than an annual flow of 66655 dam^3, the median for the 1912-74 data base), 12 (or 41 percent) of the years would have the same annual flow as the simulated historical record. Eleven years would have reductions in annual flow of greater than 13 percent, occurring for the most part during periods of moderate to high water yields within the basin. It is noteworthy that the predicted reductions in flow during the open water period would occur mainly during wet years, and only for the months of June, July and August. September remains essentially unaltered from the simulated historical. However, the October flow reductions which would occur in 13 of 63 years, would almost always occur during dry conditions. This would possibly result in water quality deterioration with respect to biomass, free ammonia and dissolved oxygen. The simulation runs for 1937 (Figure 6.10b) with and without the Project indicate identical flows, with the summer flows maintained at 0.566 m^3/s but zero during the winter months.

Figure 6.11 indicates that for the period 1931 to 1987, daily flows in the month of January were zero for 37 percent of the time. Flows during the months of November, December, February and March were zero for in excess of

PROJECT INDUCED FLOW CHANGES

DECREASES

Flow:	0–0.5	0.5–1	1–3	3–5	5–10	10–20	>20	Total
Jan	5	2	0	0	0	0	0	7
Feb	3	1	0	0	0	0	0	4
Mar	3	4	1	0	1	0	1	10
Apr	2	1	1	1	3	9	6	23
May	1	3	2	2	6	4	7	25
Jun	2	3	6	3	2	3	0	19
Jul	1	3	3	2	0	0	1	10
Aug	0	0	1	0	0	0	0	1
Sep	1	0	0	0	0	0	0	1
Oct	2	4	4	3	0	0	0	13
Nov	2	3	2	0	0	0	0	7
Dec	2	5	2	0	0	0	0	9

INCREASES

Flow:	0–0.5	0.5–1	1–3	3–5	5–10	10–20	>20	Total
Jan	2	1	0	0	0	0	0	3
Feb	1	2	0	0	0	0	0	3
Mar	2	0	1	0	0	0	0	3
Apr	0	0	0	0	0	0	0	0
May	1	1	0	0	0	0	0	2
Jun	0	0	3	1	4	0	0	8
Jul	0	0	0	0	2	2	0	4
Aug	0	0	0	0	1	1	0	2
Sep	0	0	0	0	0	0	0	0
Oct	0	0	0	0	0	0	0	0
Nov	0	1	0	0	0	0	0	1
Dec	0	0	0	1	0	0	0	1

Number of years in the period 1912–74 when, under Project conditions, the monthly flows (m3/s) would have increased or decreased relative to simulated historic flows at the North Dakota–Manitoba boundary

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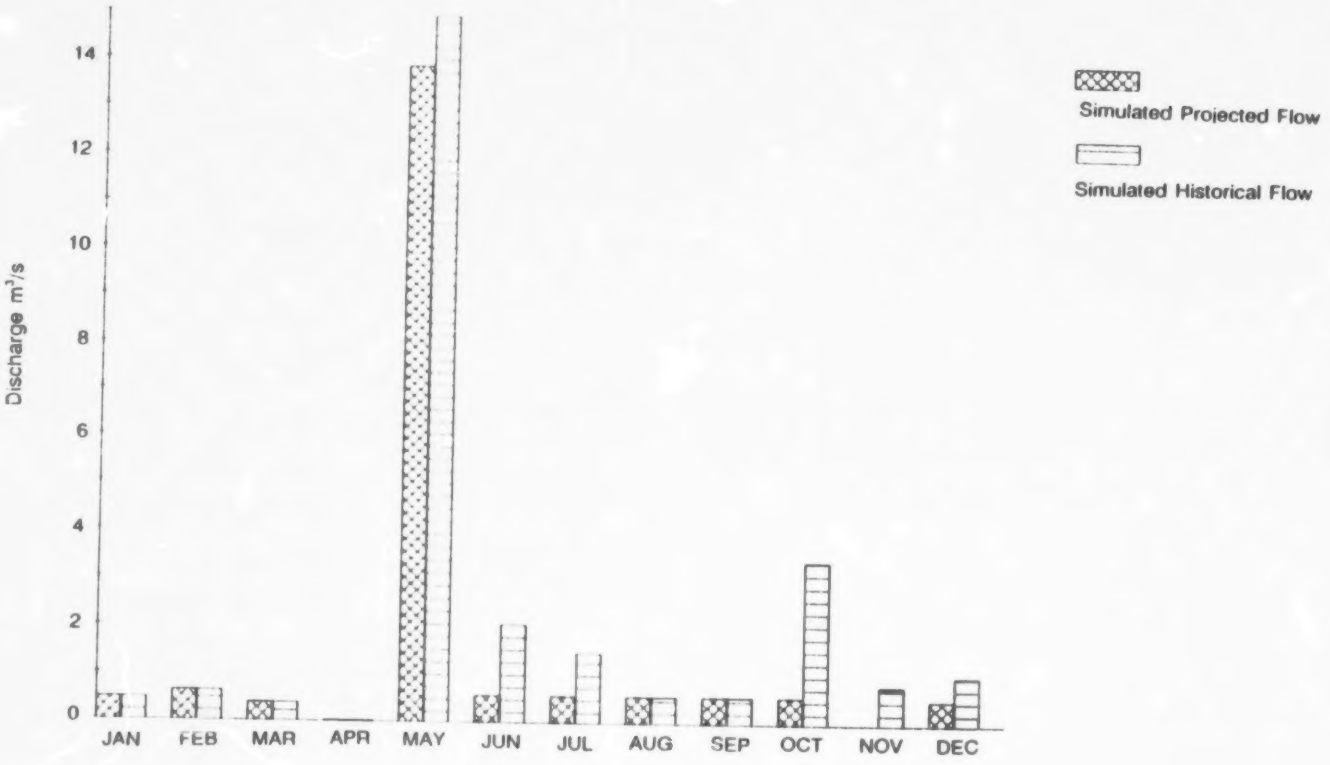
TABLE: 6.11 Project Induced Flow Changes

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SOURIS RIVER AT WESTHOPE:
SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1922 (AVERAGE YEAR)
MEAN MONTHLY FLOW m³/s, (50:50/IRRIGATION/START FILLING 1912)



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Initial Environmental Evaluation

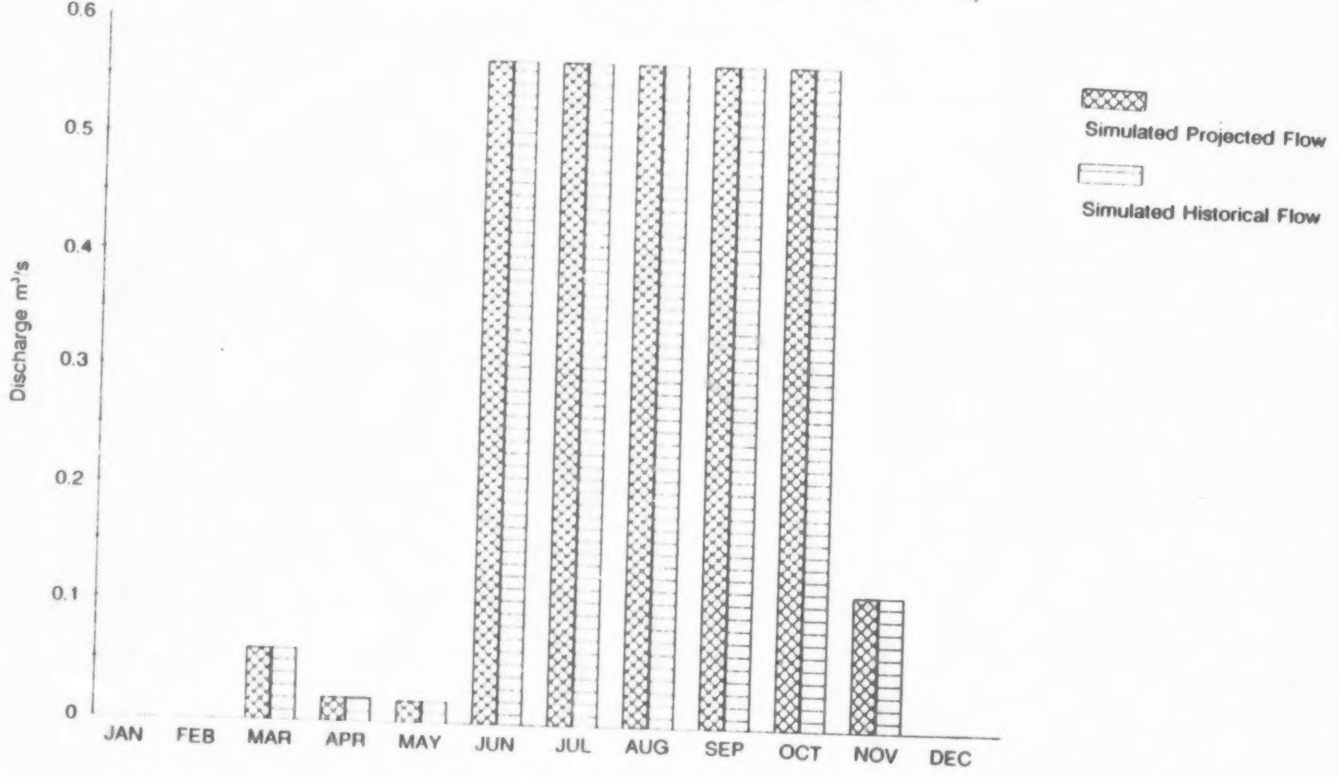
FIGURE: 6.10a

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SOURIS RIVER AT WESTHOPE:

SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1937 (DRY YEAR)
MEAN MONTHLY FLOW m^3/s, (50:50/IRRIGATION/START FILLING 1912)



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Initial Environmental Evaluation

FIGURE: 6.10b

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SOURIS RIVER AT WESTHOPE:

SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1955 (WET YEAR)
MEAN MONTHLY FLOW m^3/s, (50:50/IRRIGATION/START FILLING 1912)

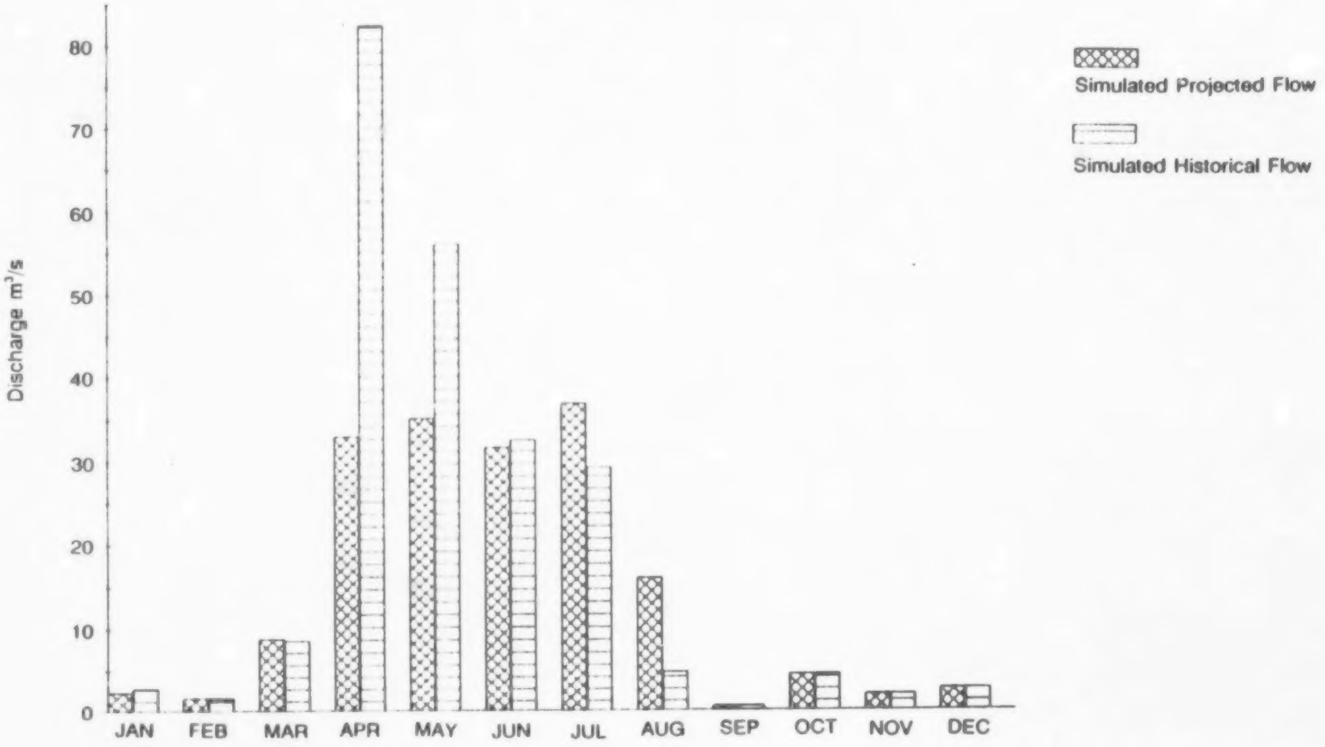

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FIGURE: 6.10c

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SOURIS RIVER AT WESTHOPE:
SIMULATED PROJECTED AND SIMULATED HISTORICAL FLOWS, 1965 (AVERAGE YEAR)
MEAN MONTHLY FLOW m^3/s, (50:50/IRRIGATION/START FILLING 1912)

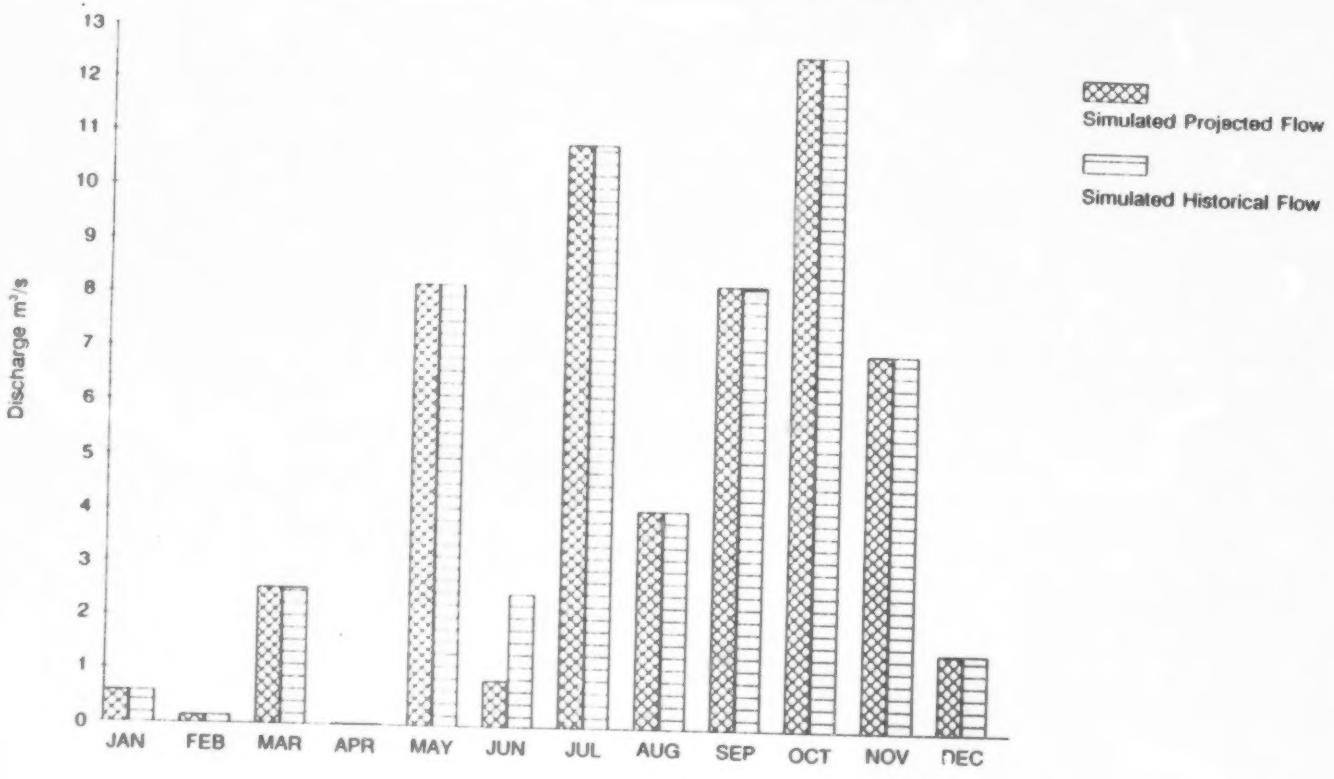

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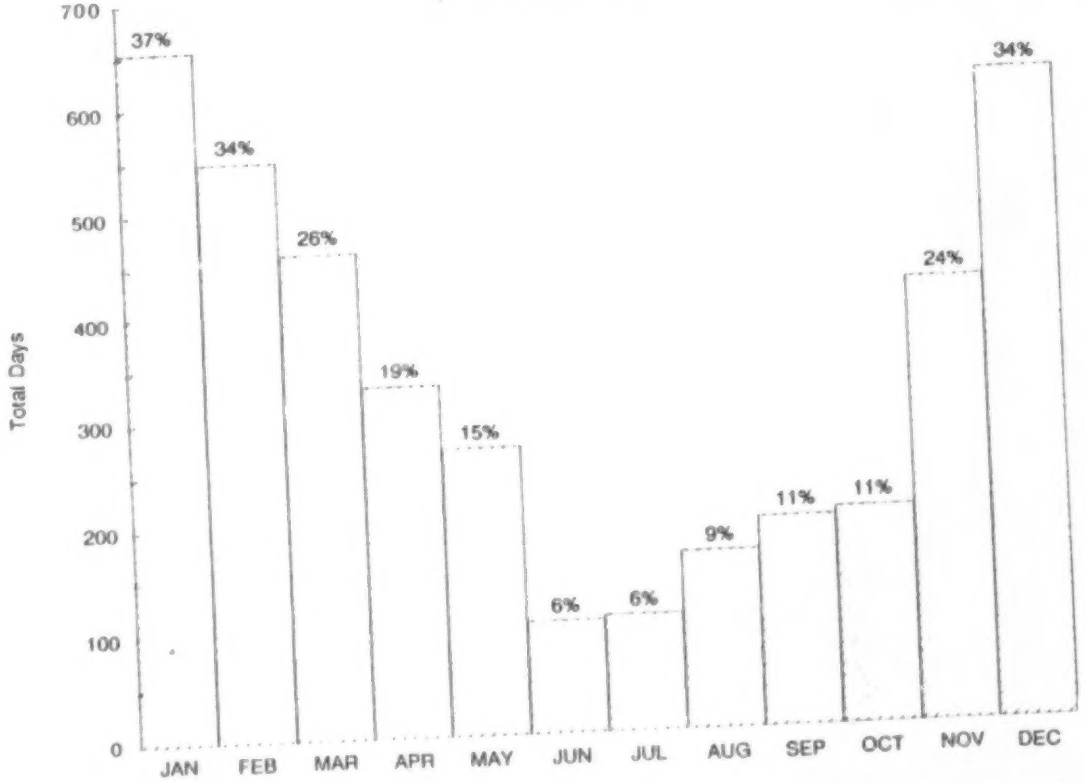
FIGURE: 6.10d

SOURCE: Environment Canada Conservation and Protection

ZERO FLOW FREQUENCY DISTRIBUTION FOR SOURIS RIVER AT WESTHOPE,
1931 - 1987
(WITH % DURATION)



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DATE: July, 1989

Rafferty - Alameda Project
Initial Environmental Evaluation

FIGURE: 6.11 Zero Flow Frequency Distribution at Westhope

SOURCE: Environment Canada Conservation and Protection

24 percent of the time. A low flow analysis is provided in Section 5, which indicates that monthly flows of 0.0 m^3/s would occur one percent more frequently under Project conditions (12 percent of the time in a 44-year period as opposed to 11 percent of the time based on simulated historic records). Recent analyses by Manitoba indicate that the drought criteria under the Interim Measures would have been invoked as many as 12 times under Project conditions compared to 5 times, using simulated present conditions.

Lower summer flows would aggravate an already serious water quality problem (algae proliferation) within the quiescent reaches of the river near the towns of Melita and Souris. The immediate impacts would be on the recreational value of the river as the aesthetic quality would be damaged by nuisance growths of Cladophora. Large diurnal variations in the dissolved oxygen content would continue possibly at an increased magnitude and may result in a higher incidence of fish kills (Section 8).

Toxic levels of ammonia have been recorded in excess of Manitoba water quality objectives, North Dakota water quality standards, and the Canadian water quality guidelines. Figure 6.3 shows at what level total ammonia is associated with toxic concentrations of free ammonia and compares this to historically recorded data. Although the period of record plotted is very short, it shows that ammonia toxicity is most likely during the late summer to early fall but can occur during mid-winter. There is a lack of information from the SBDA and the U.S. Army Corps of Engineers on the projections of free ammonia (and other parameters) for the North Dakota-Manitoba boundary. Intuitively, one would anticipate that the frequency of non-compliance would increase during the late summer because of Project-reduced flows. The refuge, with its high productivity and organic carbon content, only serves to augment ammonia problems.

A reduced overall annual volume of water would reduce the annual nutrient loading to the Souris River. The timing of reduced water volumes to Manitoba could create a problem related to municipal discharge downstream. The towns of Hartney, Melita, Souris and Wawanesa discharge treated effluent to the Souris River (Table 6.2). Management of these wastes during low to moderate flows would require the towns to schedule their releases to obtain maximum dilution ratios. It is possible that upgrading of sewage lagoons may be required in order to allow adequate long term storage over critical low flow periods.

It is probable that the annual variation in the concentrations of salts and metals would continue to vary within historical ranges with a small but gradual increase over the long term. It is important to remember that Manitoba is predicted to receive about 80 percent of the water volume it has received historically. Water quality at the boundary, particularly during low flow, requires modelling by the Proponent and the U.S. Army Corps of Engineers and subsequent review and approval by all parties concerned. Increases in TDS, bacteria and nutrients could have implications for livestock and future opportunities for irrigation.

Average Flow Period

Manitoba has stated that the **"flow simulations indicate that average (annual) flows in the Souris River would be reduced by project operations but that North Dakota would have sufficient river flows to continue to pass to Manitoba the flow volume stipulated in the Interim Measures....In fact, according to the post-project simulations, flows in the July to September period would be higher under full project operation"** (Manitoba, 1988). The July to September statement is no longer accurate on the basis of updated computer simulations of historical versus Project flows. In fact, according to Table 6.11, flows for the period July to September would be reduced 12 years out of 63 and increased in 6 years, otherwise the flows would remain unchanged.

In 1965, an average flow year, the predicted monthly flows would have been the same as the simulated historical except for the month of June when the flows would have been reduced by about 66 percent whereas for the entire year the annual flow would have been reduced by only 3 percent. This reduction in June flows could cause earlier algal blooms because of higher instream temperatures (earlier in the season than normal) and lower river velocity.

High Flow Period

The Souris River during wet years under Project conditions would present an interesting challenge for water managers. Water quality would be improved in otherwise dry periods. On the other hand, the flooding duration would be extended with a second flow peak in the summer. Relative to the historical period, there would be less total volume of water during the spring period and therefore, lower flushing potential for downstream reaches of the Souris River. A reduction in spring flows should mean less refuge wastes reaching Manitoba.

So is water quality better or worst under Project conditions and wet years? According to hydrology simulations, had the Project been in place since 1912, the flows throughout 1955, a wet year, (Figure 6.10c) would have been the same or higher (and therefore water quality probably better) than pre-Project conditions for all months except April, May and June.

6.2.4.2 Water Quality Predictive Capability

The supplemental reports from the Proponent and correspondence from the USEPA have served to instill confidence in the model predictions for phosphorus, dissolved oxygen, metals and dissolved constituents for the Saskatchewan-North Dakota boundary. The discrepancy between the USEPA and SBDA data over the predicted free ammonia concentrations is not serious. The important point is that there is a potential for periodic high free ammonia concentrations during the late summer at the Saskatchewan-North Dakota Boundary caused by releases from the reservoirs. The free ammonia model does have weaknesses related to its inability to react to changing pH and temperature but these are not considered significant since the model is intended to consider worst case possibilities. The models have not yet been fully calibrated or verified using real data from the study area. Modelling of free ammonia (and other constituents) through to the North Dakota-Manitoba boundary has not been done for low flow situations.

The time of travel estimates provided by Environment Canada and those used by the SBDA differed but only the SBDA estimates were used. The faster time of travel predicted by Environment Canada would alter the model results mainly during low flow periods. The effect of faster time of travel would be to extend the zone of recovery into North Dakota. Free ammonia originating in Saskatchewan would not reach Manitoba. Field dye studies by McDonald and Hamilton (1989) indicate that the river velocities included in the original model runs were substantially over-estimated. The difference between time of travel estimates is not critical but deserves to be reconciled over the long term for various discharge conditions.

6.2.4.3 Irrigation Effects

Because of its proximity to the boundary, the Eaton Irrigation District (4050 ha) has a greater potential to impact on Manitoba than the planned irrigation (about 4855 ha) in Saskatchewan. However, flood irrigation is used in the Eaton Irrigation Project, for the production of hay. The supplemental SBDA EIS reports considered both diffuse sources and irrigation return flows (10 percent of quantity applied) in terms of amount and quality. These characteristics, which were derived through international consultation (McDonald and Hamilton 1988), are believed to be reasonable and indicative of worst case conditions.

Return flow concerns relating to pesticides are justifiable on the basis that pesticide use can be expected to increase with irrigation. However, the possibility of detecting increases in pesticide levels above what has been recorded is small, as only 10 percent of the applied water would return to the Souris River, only 1 percent of an applied pesticide is lost to surface runoff, most pesticides now in use are of short life expectancy (non-persistent), and many pesticides are adsorbed to sediments. That is not to say that some pesticides, which may be downwardly mobile through the soil profile (for example, picloram, depending on the soil type), would not reach the river. Once the irrigation development details are known, the information should be provided to the monitoring agencies so that monitoring protocols can be adjusted to reflect what is happening.

6.2.4.4 Mercury

In downstream areas, mercury would not be expected to become a greater problem than at present. Both North Dakota and Manitoba have reported elevated levels of mercury in fish within their portions of the Souris River basin. Mercury in the water column is readily scavenged by particulate material and would, for the most part, remain within the reservoirs. Mercury in water from below Cookson Reservoir on the Poplar River system, for example, has not increased over the historical levels.

6.2.4.5 North Dakota Water Management-Induced Effects

The most important consideration to Manitoba with respect to impacts on water quality is the collective effects of both the Project and the hydrologic works which the United States would undertake in response to upstream water management developments in Saskatchewan. These works involve mitigation measures on Lake Darling (raising the level), modification to the J. Clark Salyer NWR and a modified water operational plan for the two refuges. The implications of these works would depend upon whether the year was dry, normal or wet.

The quality of the Souris River at the North Dakota-Manitoba boundary has depended, and would continue to depend upon, the operation and quality of water released from Lake Darling and J. Clark Salyer NWR. As discussed earlier, historical water quality has been plagued with low dissolved oxygen throughout the winter and other low flow periods of the year. During the summer, reduced flows are problematic due to the high nutrient content, high temperatures and diurnal variations in dissolved oxygen.

6.3 Overview Statement

Findings concerning the impacts of the Project on water quality have been broken down by jurisdictional area: Saskatchewan, North Dakota and Manitoba. However, the area of primary interest to the federal government is the quality of transboundary waters. Tables 6.12 and 6.13 summarize water quality changes that would be expected at the Saskatchewan-North Dakota boundary and at the North Dakota-Manitoba boundary.

6.3.1 Saskatchewan

In Saskatchewan, water quality in the Souris River would be altered from natural conditions primarily because of the altered hydrologic regime and the relatively high dissolved substance concentrations in the water discharged from the Rafferty Reservoir. Retention time in the Reservoir would be long, and evaporation would result in dissolved substance levels increasing by up to three times within the reservoir. Maximum concentrations in the Reservoir would be less than natural concentrations under low flow conditions in fall and winter. In successive dry years, water quality for some dissolved substances would exceed irrigation use guidelines for selected sensitive market garden crops. However, water from the Reservoir would be suitable for irrigation of forage and grain crops in most years. Aquatic life should generally benefit from the improved base flow provided for irrigation use, although free ammonia levels and low dissolved oxygen in the discharge from the Reservoir could adversely affect aquatic life forms for tens of kilometres downstream, especially under extreme low flow conditions in summer and fall.

SUMMARY OF PROJECTED LONG TERM WATER QUALITY IMPACTS SOURIS RIVER AT THE SASKATCHEWAN - NORTH DAKOTA BOUNDARY, RELATIVE TO EXISTING WATER QUALITY

Parameter	Spring	Summer	Fall	Winter	Impact
Flow	—	–/+	–/+	–/+	Seasonal
Aesthetics	+	+	+	0	Open Water
Ammonia	0	+/–	+/–	0/+	Sum/Fall
Boron	+	+	-	—	Long Term
Chloride	+	+	-	—	Long Term
Dissolved Oxygen	0	0	0	-	Low Flow
Biological Diversity	+	+	+	0	Long Term
Nutrient Enrichment	—	-	-	0	Long Term
Mercury–Fish	0	0	0	0	None
Mercury–Water	0	0	0	0	None
Metals–heavy	0	0	0	0	None
Pesticides	0	0	0	0	None
pH	0	0	0	0	None
SAR	+	+	-	—	Long Term
Sodium	+	+	-	—	Long Term
Sulphates	+	+	-	—	Long Term
TDS	+	+	-	—	Long Term
Turbidity	—	-	0/+	0/+	Short Term

Symbols: + = slight increase; ++ = significant increase; - = slight decrease; — = significant decrease; 0 = no significant change; +/– = increases and decreases with increases dominating; –/+ = decreases and increases, with decreases dominating

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Initial Environmental Evaluation

TABLE: 6.12 Summary of Projected Long Term Water Quality Impacts

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

SUMMARY OF PROJECTED LONG TERM WATER QUALITY IMPACTS SOURIS RIVER AT THE NORTH DAKOTA - MANITOBA BOUNDARY, RELATIVE TO EXISTING WATER QUALITY

Parameter	Spring	Summer	Fall	Winter	Impact
Flow	—	0/-	0/-	0/-	**Seasonal**
Aesthetics	+	0/—	0	0	Open Water
Ammonia	0	+	+	0	**Sum/Fall**
Boron	0	+	+	+	Long Term
Chloride	0	+	+	+	Long Term
Dissolved Oxygen	0	-	-	-	Low Flow
Productivity	+	+	+	0	Open Water
Nutrient Loading	—	+/-	+/-	0	Long Term
Mercury-Fish	0	0	0	0	None
Mercury-Water	0	0	0	0	None
Metals-heavy	0	0	0	0	None
Pesticides	0	0	0	0	None
pH	0	0	0	0	None
SAR	0	0	+	+	Long Term
Sodium	0	+	+	+	Long Term
Sulphates	0	+	+	+	Long Term
TDS	0	+	+	+	Long Term
Turbidity	—	+	0	0	Seasonal

Symbols: + = slight increase; ++ = significant increase;- = slight decrease; — = significant decrease; 0 = no significant change; +/- = increases and decreases, with increases dominating; -/+ = decreases and increases, with decreases dominating

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TABLE: 6.13 Summary of Projected Long Term Water Quality Impacts

DATE: July, 1989

SOURCE: Environment Canada Conservation and Protection

Alameda Reservoir would contain water of superior quality to that in Rafferty Reservoir. At the junction of Moose Mountain Creek and the Souris River, water from the Alameda Reservoir would dilute poor quality water discharged from the Rafferty Reservoir. This dilution would benefit aquatic life and improve irrigation water quality. Dilution would also be necessary to meet Canadian water quality commitments to North Dakota under the terms and conditions of the Boundary Waters Treaty of 1909.

In relation to future water quality within the Souris River basin, this is an important point: a flood of 1:100 or greater would fill all reservoirs in the basin with high quality water (TDS<300 mg/L). This exceptional quality water would be maintained within the reservoirs and the mainstem Souris River for several years following this event.

Mercury concentrations in fish tissue would increase before reaching a stable condition. Maximum levels slightly in excess of human consumption guidelines of 0.5 mg/kg are anticipated with a lower long term stable concentration (after approximately 10 years). Pesticide levels in the Souris River are not expected to increase measurably, however, disposal sites for pesticide containers must be cleaned up before flooding occurs in the reservoir areas.

6.3.2 North Dakota

The quality at the Saskatchewan-North Dakota boundary would be improved or impaired depending on the storage situation in the upstream reservoirs and the quality of their discharge. If wet years prevail, opportunities to improve upon existing water quality would occur during the months of June and July. During dry years, which follow normal or high water years, flows from the reservoirs should improve upon historical water quality. It is important to note that flow increases under Project conditions, above historically recorded, would be the exception not the rule. Spring water quality at the international boundary may be impaired slightly relative to existing water quality because of the flow reduction but would still be within North Dakota water quality standards and without impact on existing uses. Water quality during the remainder of the year would be better than existing conditions, with fewer exceedances of the standards for TDS, sulphate, chloride, and boron.

There is a remote possibility that anoxic water discharged from the hypolimnion of the reservoirs or anoxic waters advanced under ice ahead of late winter releases may reach the international boundary. Should this occur, as is predicted by the USEPA under a worst case scenario, the North Dakota standard for free ammonia would be exceeded, with potential impacts on aquatic life. Also, should Rafferty Reservoir releases constitute a significant proportion of the Souris River flow during the summer, fall and winter, there would be increased frequency of exceedances of Canadian water quality guidelines for other substances: TDS, chloride, sulphate, boron, and possibly dissolved oxygen. Lake Darling would buffer downstream reaches from most if not all of any adverse effects directly attributable to water quality of the Canadian reservoirs. However, changes in the operation of Lake Darling resulting from reduced flows from Saskatchewan would themselves induce water quality changes downstream.

The quality of water in the Souris River, the J. Clark Salyer NWR, and Lake Darling would be impaired because of the reduced beneficial effects of flushing with good quality high flows in spring. The assimilative capacity of the Souris River below the treated municipal effluent outfall from the city of Minot would be reduced because of a reduction in annual flow. Lower water delivery to J. Clark Salyer NWR would possibly exacerbate botulism among ducks. Dissolved substances in the refuges are expected to continue on a gradual upward trend until such time as a major flood within the basin sets the TDS back to a lower level. Lake Darling would benefit from reduced sedimentation and nutrient loading, but the aquatic community in this lake would experience anoxic conditions in late winter more frequently in the future because of Saskatchewan's 50 percent holdback. Mercury in fish of Lake Darling is not expected to increase significantly.

In wet years, release of the flood pool from upstream could cause refuge management problems and potential flushing of nutrient-rich sediments downstream into Manitoba.

6.3.3 Manitoba

In Manitoba, water quality at the international boundary is not expected to be altered significantly by water quality of the Saskatchewan reservoir releases. The Rafferty and Alameda dams are over 660 kilometres from the North Dakota-Manitoba boundary. Over this distance, physical and chemical processes in the river and the refuges would attenuate the major water quality impacts of the Project and associated hydraulic works in the United States. However, water quality under low flow conditions may be affected because the United States would deliver to the Manitoba boundary only sufficient water to meet the requirements of the Interim Measures (0.566 m^3/s). Increased declaration of drought conditions by North Dakota would result in more frequent zero or low flow situations and higher concentrations of free ammonia and available dissolved nutrients. High levels of free ammonia could adversely affect aquatic life, and nutrient increases may stimulate thick growths of undesirable filamentous algae.

Flow reductions in the Souris River at the North Dakota-Manitoba boundary, due to the Project, would have occurred 44 years out of 63 during the period 1912 to 1974, had the Project been in place. Therefore, it is readily apparent that summertime flow augmentation would be an exception. When it does occur, water quality should be improved, particularly with respect to biological productivity.

Nutrient levels at the Manitoba boundary are presently high, probably because of the presence and operation of the national wildlife refuges in North Dakota and municipal treated effluent discharge to the river from the city of Minot. A modified operation plan for effluent discharge and refuge management could possibly be further optimized to mitigate some of the adverse effects caused by the Project.

Wastewater assimilation in the Souris River in Manitoba may also be affected during more frequent periods of low flow. The four municipalities of Melita, Hartney, Coulter and Souris all discharge sewage effluent into the Souris River. To maintain adequate water quality, it may be necessary to schedule releases and increase the capacity of lagoons to hold larger volumes of waste through extended drought periods.

6.4 Mitigation of Project Impacts

The mitigation requirements described below are thought to ameliorate most of the water quality impairments identified in this evaluation. Those areas where further information is required before final judgements can be made concerning mitigation are included in Section 6.6 under information deficiencies. Some unmitigable impacts have been identified in Section 6.5. The following mitigation requirements are presented in no particular order.

6.4.1 Saskatchewan

1. The water quality data base generally encompasses the time period 1974 to present whereas the hydrologic data base used in the simulations and assessment extend only to 1974. This has created interpretative difficulty for water quality. In order to more confidently understand the Project-induced flow impacts on water quality, it is essential that the computer simulations be updated to 1988.

2. Due to the uncertainties associated with the water quality predictions related to the reservoirs and downstream areas, Canada, in cooperation with the Proponent and affected jurisdictions, must develop a water quality management plan, as part of a basin-wide comprehensive water management plan, to include basin water quality characterization, identification of issues and options for protecting or enhancing water quality, monitoring of Project impacts, trends and compliance with transboundary standards or objectives (and the Boundary Waters Treaty).

3. The SBDA through partnership with the city of Minot have designed a two level discharge outlet into Alameda Reservoir. This feature with a multi-level outlet for Rafferty Reservoirs, would facilitate water quality management choices for controlling and maintaining acceptable water quality in transboundary waters, particularly as related to anoxic conditions.

4. At all waste and pesticide container disposal sites within the proposed reservoir areas the soils must be tested, contaminated soil isolated or removed, and affected areas declared safe before flooding is permitted.

5. The operational plan for the Canadian reservoirs must allow for flow adjustments to meet transboundary water quality requirements (e.g. use of Alameda water to dilute Rafferty releases).

6. Riffle areas and irrigation impoundments (weirs) would enhance instream recovery from anoxic water quality conditions so that these conditions do not become a transboundary issue. Opportunities to achieve water quality benefits from these weirs and from artificial riffle areas should be considered by the Proponent.

7. Sound water management practices on and contiguous to the reservoirs would serve to protect reservoir water quality and therefore, provide an added degree of protection to transboundary water quality. Consideration could include landuse controls, water use controls, reservoir use capacity studies, boat restrictions, etc.

8. Upsurge of nutrients, metals and salts in newly created reservoirs can be partially controlled (minimized) through proper preparation of a reservoir base (clearing).

9. Rafferty Reservoir water quality objectives should be established for TDS and selected constituents to trigger implementation of water quality management options and early warning for North Dakota and Manitoba.

10. Canada and affected jurisdictions should establish transboundary water quality objectives (Saskatchewan and Manitoba boundaries) through international negotiations prior to project approval to serve as guidelines in the management of upstream water. Objectives should be established for only those constituents that are predicted to be altered.

11. Channelization below Rafferty should include a plan to dispose of dredged materials appropriately so that they do not impact on transboundary water quality.

6.4.2. North Dakota

1. Both U.S. and Canadian authorities (federal and provincial) must monitor on an ongoing basis the level of mercury in fish and produce consumption advisories or guidelines to protect the public, as required.

2. Further refinement of the refuge operating plans to meet both the refuge objectives and international water quality objectives should be investigated.

3. The U.S. Army Corps of Engineers has noted that the city of Minot may have to further upgrade its municipal effluent treatment to avert related impacts on downstream water uses, if the dilution capacity of the Souris River is significantly reduced.

4. Water quality of the Souris River in Manitoba during low flow periods would remain the same or deteriorate further under Project conditions. Opportunities to protect or enhance water quality in Manitoba during critical low flow periods must be considered in a basin-wide context. These should include flow augmentation in North Dakota, increased apportionment to the United States, and additional storage in the Saskatchewan Reservoirs, United States or Manitoba (for example, Antler and Gainsborough creeks) during wet years for release during dry years.

5. Transboundary water quality objectives should be established through international negotiations to serve as guidelines in the management of upstream water. Objectives should be established for only those constituents that may be influenced by upstream activities.

6. Aeration of J. Clark Salyer NWR releases should be considered as a means of improving the quality of water entering Manitoba particularly when anoxic waters are released.

6.4.3 Manitoba

1. The four municipalities of Melita, Hartney, Coulter and Souris all discharge sewage into the Souris River. To maintain adequate Souris River water quality, the timing of releases may require change as may the capacity of lagoons to hold larger volumes of waste through extended drought periods. Upgrading of treatment facilities may also be an alternative, and if necessary, would require compensation.

2. Canada, in cooperation with the jurisdictions concerned, should develop a comprehensive water management plan for the entire Souris River basin. As part of this plan, an International Committee should be established to oversee water quality throughout the basin and to monitor compliance with water quality objectives.

6.5 Residual Impacts

6.5.1 Saskatchewan

1. A increasing trend in Rafferty Reservoir TDS concentrations over a period of several decades is inevitable. The same is true for the trophic status of Rafferty Reservoir.

6.5.2 North Dakota

1. Eutrophication of Lake Darling is a natural long-term aging process and can only be retarded not prevented. Lower water levels and spring flushing may accelerate the process even though nutrient loading and sedimentation from Canada is reduced.

6.5.3 Manitoba

1. Evaporative losses would increase within the United States and Saskatchewan portion of the basin under Project conditions. This would cause the dissolved constituents in the transboundary waters of the river to gradually increase over time.

6.6 Information Deficiencies

The evaluation of the Project's water quality impacts has identified a number of information deficiencies. Some of these are significant deficiencies that must be addressed before the Project proceeds, whereas others are of a minor nature and could be addressed before or after construction of the Project.

6.6.1 Information Deficiencies of High Significance

International Transboundary Water Quality Objectives

Had transboundary water quality objectives been in place when this evaluation was undertaken, it would have been possible to identify which changes in quality would be acceptable or unacceptable to North Dakota and to Manitoba. Instead, the assessment has had to rely upon objectives from Saskatchewan and Manitoba, North Dakota Standards and the Canadian Water Quality Guidelines. In some instances these differed.

Development of objectives should be undertaken immediately for those parameters that are considered most likely to be impacted by the Project and associated works in the United States. These include: dissolved oxygen, ammonia, total dissolved solids, sulphates, chlorides and boron. Development of other objectives may be desirable in the long term and should be part of an international water quality monitoring plan.

Operational Plan of the National Wildlife Refuges

The water quality impacts at the North Dakota-Manitoba boundary would be largely a direct result of how the national wildlife refuges are operated. The plan which the United States would implement remains speculative. A precise plan must be presented to all agencies concerned and an assessment undertaken concerning the water quality implications, and the opportunities for mitigation.

Water Quality Predictions for the North Dakota-Manitoba Boundary

The EISs from the SBDA and the U.S. Army Corps of Engineers fail to consider comprehensively the collective impacts of the Project in Saskatchewan and the Souris Basin Project in North Dakota on the quality of the Souris River at the Manitoba boundary.

Recent modelling conducted in Saskatchewan, United States and Manitoba portions of the basin, subsequent to the SBDA EIS, must be reviewed and given the stamp of approval by all parties. Further scientific consideration must be given to water quality during low flow conditions.

6.6.2 Information Deficiencies of Moderate Significance

Relationship of Flow to Aquatic Ecology

Water quality of the Souris River in Manitoba is a reflection of the collective land and water uses upstream in North Dakota and Saskatchewan. Information is absent on how the aquatic ecosystem of the river would respond to the changed flow regime and specifically, the modified operation of the refuges which may impact upon biological productivity. This information is required in order for Manitoba to maximize the benefits of water use within its jurisdiction.

Spring flushing of the river channel is an important phase of the aquatic ecology. The reduction in spring flows by as much as 50 percent at the Saskatchewan-North Dakota boundary would have an impact on the stability of the aquatic ecosystem of Lake Darling. In anticipation of a major spring flood, the reservoirs would be drawn down in February and early March thereby increasing the river flows above what would be normal. Virtually no attempt has been made to assess the impact of these changes in the hydrologic regime on stream and lake ecology.

Water Quality Models Calibration and Verification

The water quality models used by the Proponent have not been fully field tested, calibrated or verified within the Souris River basin, although some testing was undertaken in 1989. This deficiency places some doubt upon the results. The ammonia predictions have been corroborated by an independent agency although such has not occurred for most of the other water quality characteristics. The Proponent should undertake appropriate work to fill this information gap and subject the final results to review by all agencies. Confidence in the model is essential before implementing specific mitigation plans which may be costly and before agencies can be confident that the important water quality aspects have been adequately dealt with. Results obtained could be used, if necessary, to modify the draft operational plan.

6.6.3 Information Deficiencies of Low Significance

Ground Water as a Source of Water to Rafferty and Alameda Reservoirs

Ground water pumping into Rafferty or Alameda reservoirs has not been formally proposed and therefore, is not part of the Project being assessed in this EIS. The question has been raised about ground water use, however, because of the precedent set at Boundary Reservoir during 1988. Because of the potential impact of ground water pumping on reservoir water quality, and subsequently upon the quality of international waters, Environment Canada requires clarification as to the Proponent's intent concerning this option. Should ground water constitute a viable option of water supply to Rafferty or Alameda, the water quality predictions contained within this report would all have to be reconsidered.

Moose Mountain Creek Water Quality Data Base

Moose Mountain Creek has been classified as being of superior quality relative to the Souris River. This has been done on the basis of a monthly data base that extends primarily over the unusually wet period, 1972 to 1976. Therefore, it is not representative of normal hydrologic conditions experienced in its basin. A comprehensive data base would allow the authorities to more accurately assess the role of Alameda Reservoir releases in relation to Rafferty and would help refine the predictions for Souris River transboundary water quality.

Irrigation Return Flows

Irrigation development in Saskatchewan and the resulting effects on water quality have been dealt with superficially. Water quality predictions have been based upon many assumptions without strong substantiation. Irrigation return flows should not be a major concern given the size of the proposed development (4800 ha), the likely volume of return flow, and the number of years required to reach full development. Nevertheless, the Proponent should provide more definitive information on the water quality impacts of irrigation development.

7 MIGRATORY BIRDS

7.1 Introduction

During the public hearings held by the Rafferty - Alameda Board of Inquiry, various concerns were expressed about the predicted impact of the Project on wildlife in general (Rafferty-Alameda Board of Inquiry 1988). As far as migratory birds are concerned, the greatest concern appeared to be for waterfowl. This does not mean, necessarily, that impacts on other migratory birds would not occur. Rather, it indicates that an assessment of possible impacts of the Project on migratory birds should focus on effects on waterfowl species. Consequently, while references are made in this section to migratory birds other than waterfowl, the focus of this evaluation is on waterfowl. The economic value placed on waterfowl and the existence of the **North American Waterfowl Management Plan (NAWMP)** (USFWS and CWS 1986), an international agreement signed by Canada and the United States (see subsection 7.2), provides a further rationale for this focus.

This section addresses potential impacts of the Project on waterfowl in Saskatchewan, North Dakota and Manitoba based on available information from existing data bases; no new data were gathered from additional field studies. Data on waterfowl use and habitat capability of the Souris Basin in Saskatchewan were obtained from the Souris River Basin Study (Anweiler and Blood 1978), the Burlington Dam study carried out for the International Joint Commission (International Souris-Red Rivers Engineering Board 1980), studies carried out on behalf of the Project proponent in the reservoir areas by Environmental Management Associates (Young and Ludwig 1988a,b), and the SBDA EIS (SBDA 1987a). Information on waterfowl use in the North Dakota portion of the Souris was obtained from the Burlington Dam study and the U.S. Army Corps of Engineers EIS (U.S. Army Corps of Engineers 1988). Waterfowl use along the Souris in Manitoba was determined from the Burlington Dam and Souris River Basin studies.

7.2 Migratory Birds Convention

Great Britain, on behalf of Canada, and the Unites States formally established the Convention for the Protection of Migratory Birds in 1916. Enabling legislation followed with the Migratory Birds Convention Act of 1917 in Canada and the Migratory Bird Treaty Act of 1918 in the United States which, together, form the legal basis for the conservation of migratory birds throughout North America. This basis has provided the foundation for the cooperative waterfowl management programs that have developed over time in each country.

7.3 North American Waterfowl Management Plan

The **NAWMP** was signed in 1986 by the federal Minister of the Environment and the United States Secretary of the Interior in order to establish common international population goals for North American waterfowl (USFWS and CWS 1986). The Plan recognizes that the conservation of North American waterfowl should be pursued through cooperative planning and coordinated management. Through the Plan, Canada and the United States have made commitments to work jointly to restore habitats and populations to levels last experienced in the 1970s. There are a number of statements in the **NAWMP** document that are directly relevant to the proposed project:

> **"Reversing or modifying activities that destroy or degrade waterfowl habitat is imperative to the future success of waterfowl management ... all other efforts will be in vain if the ongoing trend of habitat loss and degradation is not reversed."**
>
> (p.1, Introduction)

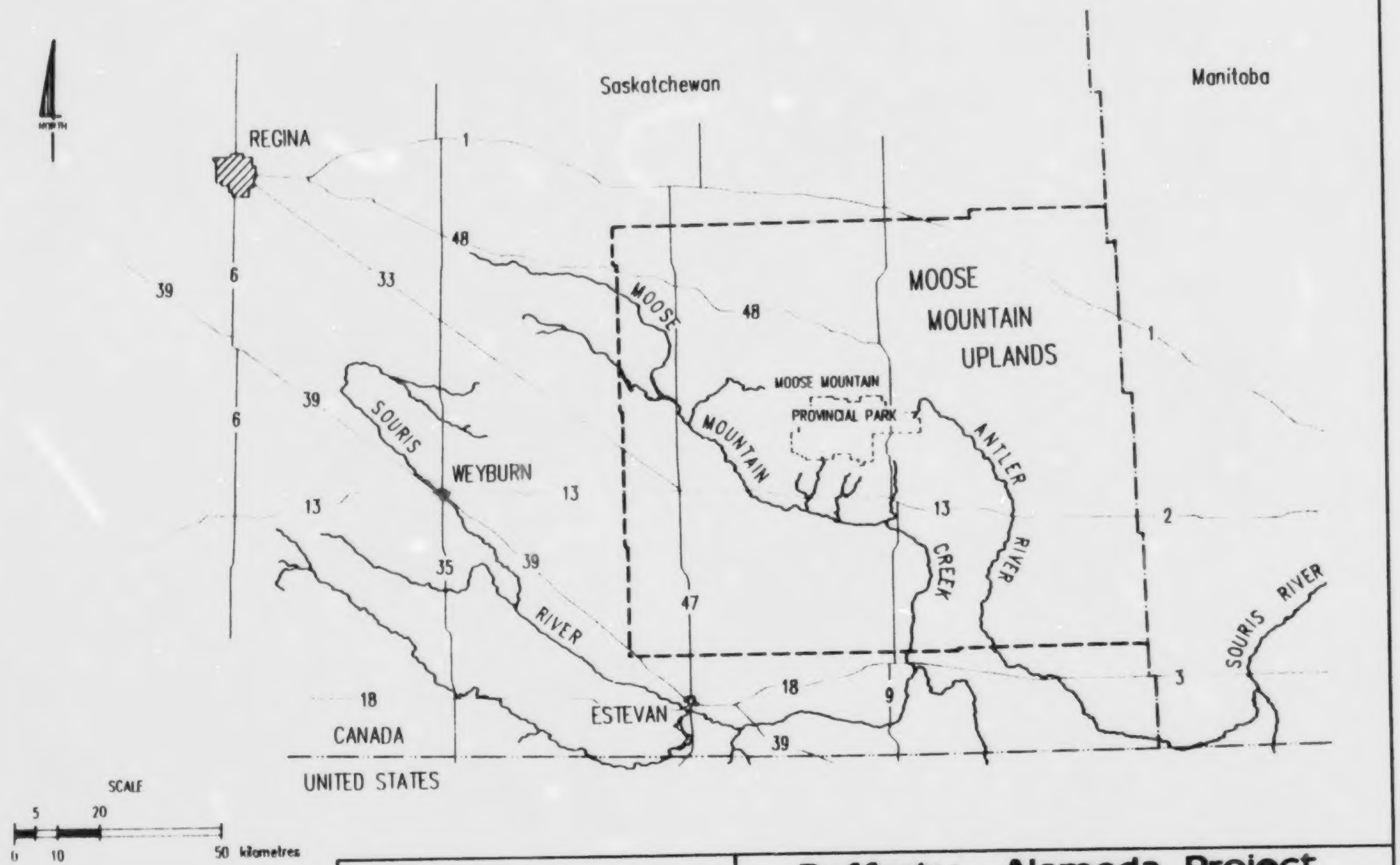
> **"The maintenance of abundant waterfowl populations is dependent on the protection, restoration and management of habitat. The persistent loss of waterfowl habitat should be reversed."**
>
> (p.2, Principles)

> **"Local governments and public land management agencies should be encouraged to zone or otherwise regulate land uses to prevent the destruction or degradation of waterfowl habitats."**
>
> (p.14, Recommendations)

> **"Public works projects planning should include the prevention or mitigation of destruction or degradation of waterfowl habitats."**
>
> (p.14, Recommendations)

Restoration of midcontinent mallard (*Anas platyrhynchos*), pintail (*Anas acuta*) and black duck (*Anas rubripes*) populations has been designated as an immediate international priority. The top priority for habitat protection is the prairie pothole breeding habitat for mallards and pintails in both Canada and the United States. Deterioration of habitat in this prairie area has been a principal cause of decline in abundance of these species.

Implementation of the **NAWMP** in Saskatchewan is to be accomplished through the **Saskatchewan Implementation Plan (SIP)**. The objective of the **SIP** is to attain, under average environmental conditions, 3 million breeding mallards in southern Saskatchewan by year 2002 (Saskatchewan **NAWMP** Technical Committee, pers. comm.). Implementation will focus on private land throughout agricultural Saskatchewan and will involve encouragement of land use practices that maintain, develop and enhance upland nesting cover. Within this zone, seven key program areas, representing the best capability for waterfowl production, have been selected. One of these program areas, the Moose Mountain Uplands, includes much of the Moose Mountain Creek drainage basin (Figure 7.1).



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Rafferty - Alameda Project
Initial Environmental Evaluation

FIGURE: 7.1 Moose Mountain Uplands, NAWMP Area

SOURCE: Environment Canada Conservation and Protection

7.4 Existing Migratory Birds and Habitat

7.4.1 Saskatchewan

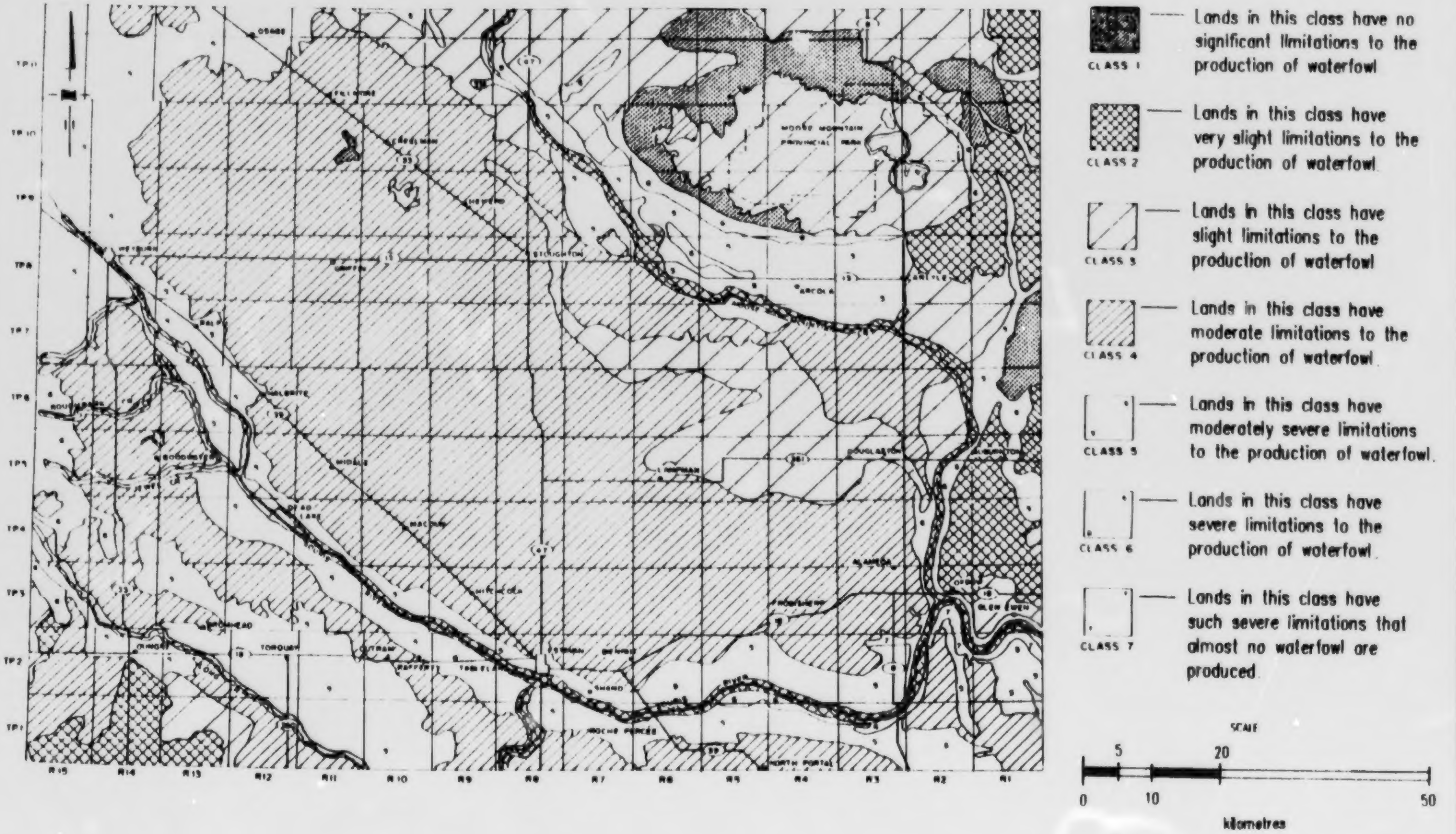
Due to the variety of habitats present, the entire Souris River Basin supports a diverse bird fauna numbering at least 225 species. The portion of the river upstream of Estevan, which runs along a fairly straight course, is markedly different in character from the downstream reach, which meanders past old oxbows. Another striking difference is the paucity of trees along the upstream reach in contrast with the largely tree-lined downstream reach.

According to the Canada Land Inventory (CLI), the best waterfowl habitat in the Souris Basin is located in the rolling glacial till plain of the Missouri Coteau, south of the Souris River, and in the Moose Mountain Upland area north of Moose Mountain Creek (Matthews and Murray 1968). These two landform units fall within two of the "strata" surveyed annually in southern Saskatchewan by the U.S. Fish and Wildlife Service and Canadian Wildlife Service in order to monitor breeding waterfowl populations. The Missouri Coteau is located within Stratum 32 and the Moose Mountain Upland occupies part of Stratum 35. Table 7.1 shows densities (birds/mi^2) of mallards, northern pintails and blue-winged teal in strata 32 and 35 compared with densities of these species in other southern Saskatchewan strata. The highest densities in 1976 were found in Stratum 35.

The Canada Land Inventory (CLI) rated the capability of lands to produce waterfowl. Ratings range from Class 1, for lands having no significant limitations to waterfowl production, to Class 7 for lands having such severe limitations that almost no waterfowl are produced. Waterfowl habitat along the Souris River is classified as either Class 2 or Class 3, having very slight or slight limitations to the production of waterfowl, respectively (Matthews and Murray 1968). Class 2 habitat is located between the Midale Dam, at the downstream end of Dead Lake, and a point near Glen Ewen, downstream of the Souris River-Moose Mountain Creek confluence, and upstream of the Weyburn Dam as far as Yellow Grass Ditch (Figure 7.2). Class 3 habitat occurs between the Weyburn and Midale dams. Waterfowl habitat along two Souris River tributaries, Roughbark Creek and Jewel Creek, is considered to be Class 3 habitat.

Natural factors limiting waterfowl production are poor distribution or interspersion of marshes or basins and reduced marsh edges due to topographic features. In addition, suitable waterfowl breeding habitat along the Souris River is restricted by cultivation, haying and grazing activities.

Except for Moose Mountain Lake, which is classified as Class 3M due to its importance as a waterfowl staging area, Moose Mountain Creek is rated as Class 2 waterfowl habitat, limited mostly by poor interspersion of marsh areas due to landform features.


TP11
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R2
R1
WEYBURN
STOUGHTON
ARCOLA
MOOSE MOUNTAIN PROVINCIAL PARK
HALBRITE
MIDALE
MACOUN
ALAMEDA
GLEN EWEN
TORQUAY
RAFFERTY
ROCHE PERCEE
NORTH PORTAL
CLASS 1 — Lands in this class have no significant limitations to the production of waterfowl
CLASS 2 — Lands in this class have very slight limitations to the production of waterfowl.
CLASS 3 — Lands in this class have slight limitations to the production of waterfowl
CLASS 4 — Lands in this class have moderate limitations to the production of waterfowl.
CLASS 5 — Lands in this class have moderately severe limitations to the production of waterfowl.
CLASS 6 — Lands in this class have severe limitations to the production of waterfowl.
CLASS 7 — Lands in this class have such severe limitations that almost no waterfowl are produced.
SCALE
0
5
10
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kilometres

Environment Canada
Environnement Canada

Conservation and Protection
Conservation et Protection

Rafferty - Alameda Project Initial Environmental Evaluation

FIGURE: 7.2 CLI Waterfowl Classification for the Souris Basin in Sask.

DATE: July, 1989

SOURCE: SBDA, 1987a

Table 7.1 Population Densities of Mallards, Northern Pintails and Blue-Winged Teal in Southern Saskatchewan in 1976 and 1986

	Mallard		Northern Pintail		Blue-Winged Teal	
Stratum	#[a]	Density[b]	#	Density	#	Density
30 1976	511.1	27.5	282.3	15.2	181.6	9.8
1986	352.2	19.0	73.5	4.0	166.0	8.9
31 1976	530.1	25.1	237.9	11.3	222.6	10.6
1986	285.1	13.5	60.1	2.9	131.2	6.2
32 1976	1036.9	27.4	1123.4	29.6	510.5	13.5
1986	463.8	12.2	216.5	5.7	251.3	6.6
33 1976	155.2	13.7	269.1	23.7	24.1	2.1
1986	70.7	6.2	78.2	6.9	20.2	1.8
34 1976	454.4	34.5	252.5	19.2	510.9	38.8
1986	271.1	20.6	52.7	4.0	180.7	13.7
35 1976	356.1	39.4	390.8	43.2	348.9	38.6
1986	156.0	17.2	65.0	7.2	129.3	14.3
TOTALS 1976	3043.8	27.4	2556.0	23.0	1798.6	16.2
1986	1598.9	14.4	546.0	4.9	878.7	7.9

[a] adjusted breeding population

[b] breeding population/mi^2 based on area of survey stratum

Source: USFWS and CWS (1976, 1986)

Limited ground-based waterfowl surveys were conducted in 1984 (SBDA 1987) along the Souris River between the proposed Rafferty Dam site and the Souris River-Roughbark Creek confluence (excluding McDonald and Dead lakes). The purpose of these surveys was to determine the potential waterfowl productivity of this reach. However, due to lateness of the surveys, it is likely that productivity was underestimated.

Duck brood density for the reach upstream of the Midale dam was projected to be 1.4 broods/km of river channel. Downstream of the dam, brood density was estimated at 5.0 broods/km (Table 7.2). Projected minimum density of duck broods for the entire survey area was 2.64 broods/km of river. Mallards constituted the majority of brood observations (79 percent) while small numbers of American wigeon (Anas americana), northern pintail and blue-winged teal broods were also encountered.

Table 7.2 **Duck Production Estimates for the Rafferty Reservoir Area on the Souris River, 1984**

Location	River Channel Length(km)	# of Broods/km of River Channel	Total Duck Broods	Total Ducklings
Sampled Area Upstream of Midale Dam	5.0	1.4	7	40
Projected Midale Dam Upstream to Roughbark Creek[a]	25.4	1.4	36.0	206
Projected Roughbark and Jewel Creeks	14.4	1.4	20.0	115
Projected Souris River Upstream from Roughbark Creek	19.5	1.4	27.0	156
Sampled Area Downstream of Midale Dam	1.6	5.0	8.0	27
Projected Midale Dam Downstream to Rafferty Dam Site	31.2	5.0	156.0	796
TOTALS Within Proposed Reservoir (excluding McDonald and Dead lakes)	90.5	2.64	239.0	1273

[a] projected numbers based on data from sampled areas

Source: Saskatchewan Parks, Recreation and Culture, unpublished data

Further ground-based waterfowl surveys were conducted in the spring, summer and fall of 1987 by Environmental Management Associates in the proposed reservoir areas along the Souris River and Moose Mountain Creek (Young and Ludwig 1988a). On the Souris River, breeding pair and brood surveys included several kilometres of Roughbark Creek, as well as McDonald Lake and the Dead Lake channel. The Moose Mountain Creek surveys were restricted to the creek mainstem.

In the proposed Rafferty Reservoir area, brood densities ranged from 1.47 broods/km to 8.52 broods/km of river shoreline, depending on habitat types present (Table 7.3). Average brood density for the entire survey area was

6.25 broods/km. Average brood density in 1987 was more than twice that observed in 1984 (2.64 broods/km), while the number of broods observed in 1987 (806 broods) was more than three times the total number of broods estimated in 1984 (239 broods) (Table 7.4). Mallard, blue-winged teal, gadwall and American vigeon were the most common broods observed; 88 percent were dabbling duck broods.

Table 7.3 Duck Production According to Shoreline Habitat Characteristics in the Proposed Rafferty Reservoir Area, 1987

Location/Habitat	Water-body Surface Area (ha)	Water-body Shore-line Length (km)	# of IBP[a]	# of Broods	IBP /ha	IBP /km	Broods /ha	Broods /km
Souris R.-Flood Plain Agric. & Grass/Shrub	298.3	58.7	948	409	3.17	16.15	1.68	8.52
Souris R. & Roughbark Creek - Grass/Shrub	58.2	24.3	148	124	2.54	6.09	2.13	5.10
Souris R. & Roughbark Creek - Forest	49.8	21.7	68	32	1.37	3.13	0.64	1.47
McDonald Lake & Marshes Grass/Shrub	60.3	7.9	126	52	2.09	15.94	0.86	6.58
Dead Lake Grass/Shrub	68.5	8.9	53	51	0.77	5.96	0.74	5.73
Dead Lake Channel Wetlands - Grass/Shrub	37.8	7.4	207	48	5.48	27.97	1.27	6.49
TOTALS	572.9	128.9	1550	806	2.71	12.02	1.41	6.25

[a] IBP = indicated breeding pair
Source: Young and Ludwig (1988a)

In the proposed Alameda Reservoir area, a brood density of 3.26 broods/km (78 broods) of river shoreline was observed (Table 7.5) (Young and Ludwig 1988b). Most of the broods were either mallards or blue-winged teal (Table 7.6); all except one were dabbling duck broods. Brood density on Moose Mountain Creek was approximately half of the average brood density observed on the Souris River.

Table 7.4 Number of Duck Broods in the Proposed Rafferty Reservoir Area, 1987

Species	Souris R. Proposed Dam to Midale Dam	Souris R. Upstream of Midale Dam	Roughbark Creek	McDonald Lake and Marshes	Dead Lake	Dead Lake Channel Wetlands	Total Broods
Mallard	47	62	19	8	3	5	144
Gadwall	86	47	10	15	18	19	195
American Wigeon	63	32	7	10	7	8	127
Blue-winged Teal	99	31	7	14	4	5	160
Northern Shoveler	48	7	2			2	59
Northern Pintail	11	7	5		1	2	26
Wood Duck	1	1					2
Redhead	3	3		1	2		9
Canvasback	31	4		3	8		46
Lesser Scaup	14	2			7	6	29
Ruddy Duck	2	4		1	1	1	9
TOTALS	405	200	50	52	51	48	806

Source: Young and Ludwig (1988a)

Young and Ludwig (1988a,b) noted that waterfowl breeding populations in southern Saskatchewan in 1987 were substantially reduced from population levels experienced in 1986 and long-term mean levels. For example, mallards registered a 20 and 47 percent decrease, northern pintail a 38 and 78 percent decrease and blue-winged teal a 23 and 55 percent decrease from 1986 and long-term mean levels, respectively. Table 7.1 shows, for example, the substantial reductions in densities that occurred between 1976 and 1986. Therefore, in years when regional habitat conditions were far better than in 1987, such as in 1976, even higher brood densities may have been present along the Souris River and Moose Mountain Creek. In other words, from a production capability standpoint, brood densities may have been underestimated during the 1987 studies.

Table 7.5 Duck Production in the Proposed Alameda Reservoir Area, 1987

Creek Surface Area (ha)	Creek Shoreline Length (km)	# of IBP[a]	# of Broods	IBP /ha	IBP /km	Broods /ha	Broods /km
86.7	23.9	144	78	1.66	6.03	0.90	3.26

[a] IBP = indicated breeding pair
Source: Young and Ludwig (1988b)

Table 7.6 Numbers of Duck Indicated Breeding Pairs and Broods in the Proposed Alameda Reservoir Area, 1987

Species	Indicated Breeding Pairs	Broods
Mallard	61	45
Gadwall	1	1
American Wigeon	18	4
Green-winged Teal	6	1
Blue-winged Teal	45	22
Northern Pintail	6	
Northern Shoveler	7	4
Canvasback		1
TOTALS	144	78

Source: Young and Ludwig (1988b)

7.4.2 North Dakota

The Souris River and adjacent wetland areas provide valuable habitat for many bird species. The most notable feature of the Souris River wetlands is the habitat they provide for waterfowl. These wetlands are used extensively for breeding, feeding and as resting areas during spring and fall migration, and for cover during moulting, brood rearing and other post-breeding activities (U.S. Army Corps of Engineers 1988).

The two Souris River NWRs, Upper Souris and J. Clark Salyer, contain the most valuable waterfowl habitat along the river (Figure 4.6). Both refuges serve as important, dependable waterfowl habitat reserves during drought years. The primary purposes of the Upper Souris NWR, containing 12 950 ha, are production of waterfowl, provision of other necessities in the life cycles of waterfowl and water supply to the J. Clark Salyer NWR (through assured releases from Lake Darling). The primary purpose of J. Clark Salyer NWR, containing about 23 750 ha, is waterfowl and other migratory bird production. The refuge provides valuable moulting habitat for waterfowl and is an important stop-off point for migrating waterfowl and other migratory birds that breed in Canada. It is considered to be one of the most productive refuges in the United States. The two refuges together are referred to by the U.S. Fish and Wildlife Service as the "jewels" of the refuge system.

Annual duck production at the Upper Souris NWR has fluctuated significantly since 1959. Considering the 20-year period from 1959 to 1978, average duck production from the refuge was 5000 birds (Table 7.7) (International Souris-Red Rivers Engineering Board 1980). For the 20-year period 1968-1987, duck production averaged 3733 yearly (U.S. Army Corps of Engineers 1988). Historically, the greatest number of ducks produced was 11 766 and 12 426 in 1961 and 1963, respectively. In the early part of the 1968-1987 period, annual duck production ranged from 4200 to 5000. During the latter part of this period, the average dropped to approximately 2200. However, from 1985 to 1987, the annual production figures increased again to approximately 4200 to 5200 ducks.

At the J. Clark Salyer NWR, a similar pattern of general decline in annual production has occurred. For the period 1959 - 1978, duck production averaged 18 400 annually (Table 7.7) while, during the more recent 20-year period from 1968 to 1987, average duck production was 15 740.

Outbreaks of avian botulism have been a recurring problem at both refuges. The problem is poorly understood and is apparently triggered by a variety of factors. At Upper Souris NWR, it appears that botulism tends to occur during a high water year following a low water year. Once an outbreak occurs, it reappears for several years in a row. At J. Clark Salyer NWR, problems have developed under both high water and low water conditions, but appear to be most frequently associated with low pool elevations and/or reflooding of mudflats and shallow bays in late summer.

7.4.3 Manitoba

In Manitoba, the Souris River extends approximately 270 km from the international boundary to its confluence with the Assiniboine River. Its meandering course and the presence of oxbows and trees along many of its reaches causes the river to somewhat resemble the Souris River reach located downstream from Estevan in Saskatchewan.

Table 7.7 Average Duck Production Estimates for Upper Souris and J. Clark Salyer National Wildlife Refuges, 1959-1978

Species	J. Clark Salyer	Upper Souris	TOTALS
Mallard	4780	1000	5780
Gadwall	2835	800	3635
American Wigeon	1340	450	1790
Green-winged Teal	55	100	155
Blue-winged Teal	2850	1750	4600
Northern Shoveler	570	250	820
Northern Pintail	2800	150	2950
Wood Duck	230	50	280
Redhead	1250	150	1400
Canvasback	1250	150	1400
Lesser Scaup	55	50	105
Ruddy Duck	295	100	395
Hooded Merganser	90		90
TOTALS	18 400	5000	23 400

Source: International Souris-Red Rivers Engineering Board (1980)

The Souris River shorelines provide nesting habitat and migration stops for a large variety of songbirds, some of which are unique, or nearly so, to this part of the province. In addition, many raptors and shorebirds also nest near the river (Goodwin and Koonz 1978).

The Manitoba portion of the Souris River is not considered to be an important waterfowl breeding area, although knowledge of its present productivity is incomplete. The CLI classified the reach of the river from the international boundary to approximately halfway between Hartney and Souris as Class 3 waterfowl habitat, having slight limitations to the production of waterfowl (Adams and Hutchison 1968). Downstream to its confluence with the Assiniboine River, the river is rated as Class 4, having moderate limitations to the production of waterfowl. Factors limiting waterfowl production are water level fluctuation and high seasonal flows. Agricultural activities in the upland areas place further limits on waterfowl production along the Souris River and probably reduce its value to waterfowl below that indicated by the CLI ratings.

Table 7.8 lists numbers of waterfowl observed during a reconnaissance of the river carried out in July 1976. The table shows that waterfowl density downstream of Hartney (0.7 to 4.0 birds/km) was much lower than in the upstream reach (6.5 to 12.7 birds/km), as would be expected from the CLI classifications.

Table 7.8 Waterfowl Observed Along the Souris River in Manitoba in July 1976

	Reach					
Species	Border-Melita	Melita-Hartney	Hartney-Souris	Souris-Elbow	Elbow-Assiniboine	TOTALS
Mallard	105	549	37	134	21	846
Gadwall	50	16				66
American Wigeon	16					16
Blue-winged Teal	35	59	8	3		105
Northern Shoveler	8	0	5	0	0	13
Northern Pintail	17	3	0	0	0	20
Wood Duck	30	259	63	52	22	426
Unident. Dabblers	44	16	2	3		65
Redhead	1					1
Canvasback	1					1
Lesser Scaup	1					1
TOTALS	308	902	115	192	43	1560
km surveyed	47.2	71.1	45.2	48.0	61.2	272.6
Birds/km	6.5	12.7	2.5	4.0	0.7	5.7

Source: Goodwin and Koonz (1968)

7.5 Impact of the Project on Migratory Birds

7.5.1 Introduction

As stated in subsection 7.1, the potential impact of the Project on waterfowl was a major concern expressed during the Rafferty-Alameda Board of Inquiry public hearings. To a large extent, this concern stems from the fact that continental duck populations have been substantially reduced from levels experienced in the 1970s. Subsection 7.2 describes how the **NAWMP** was launched as a joint Canada - U.S. effort towards restoring continental duck populations to previous levels. While the Project would, undoubtedly, have an impact on other migratory bird species, assessment of impacts was limited to the group for which there was most concern and for which there was the greatest potential for significant impacts - waterfowl.

It is recognized that, because waterfowl are an international resource shared with the United States, any impact involving a reduction in the number of birds produced in Canada also represents an impact to the United States. Similarly, waterfowl impacts occurring in the United States also represent an impact to Canada. This is particularly true when considering the breeding populations of contiguous areas such as North Dakota, Saskatchewan and Manitoba.

During investigations of the potential effects of the proposed Garrison Diversion Unit (International Garrison Diversion Study Board 1976) and Burlington Dam projects in North Dakota, it was demonstrated that a direct loss of waterfowl production in North Dakota would also result in an indirect loss to Canada due to the interchange of ducks within the international breeding reservoir. Ducks produced one year in North Dakota may end up breeding in Manitoba, for example, the following year. In addition, a large number of ducks produced in North Dakota move north to stage in Manitoba (referred to as the "fall shuffle") before migrating south.

Similarly, a proportion of the ducks produced along the Souris River, Moose Mountain Creek and their tributaries will breed in North Dakota in subsequent years. Therefore, a direct loss of waterfowl production, due to inundation of riverine habitat by the proposed Rafferty and Alameda reservoirs, would result in an indirect loss to the United States in the form of reduced breeding populations. In addition, Saskatchewan's contribution to "fall shuffling" birds moving into the United States, and to the fall flight, would also be reduced.

In the context of the **NAWMP**, it is irrelevant whether waterfowl production losses occur directly or indirectly, in the United States or Canada. Any waterfowl losses occurring in the prairie pothole region of either country, designated as top priority habitat under the **NAWMP**, are contrary to the stated intent of Canada and United States to restore continental duck populations and, therefore, cannot be tolerated. In order to preserve the integrity of the **NAWMP**, it is essential that the concept of "no net loss of waterfowl production" be applied in mitigating impact on waterfowl caused by the Project. In North Dakota, a bill was passed in 1987 (NDCC 61-32-03) ensuring "no net loss" of wetlands due to drainage. Similar legislation does not yet exist in Saskatchewan. However, the principles behind the North Dakota bill are, nonetheless, applicable.

The following subsections consider the impact of the Project on the international waterfowl resource. For clarity, impacts are considered separately for Saskatchewan, Manitoba and North Dakota.

7.5.2 Saskatchewan

The potential impacts of the Project in Saskatchewan are:

a) loss of waterfowl production due to inundation of riverine habitat by the Rafferty and Alameda reservoirs;
b) loss of waterfowl production from habitat adversely affected by channelization below the Rafferty Dam site;
c) loss of waterfowl production through drainage of off-river wetlands stimulated by the Project;
d) increased hunting mortality due to concentration of waterfowl at the Rafferty and Alameda reservoirs; and
e) reduced capability for management of Moose Mountain Creek National Wildlife Area due to existence of the Alameda reservoir.

All waterfowl production losses have implications for the success of the **NAWMP** which are addressed in the discussion of impacts that follows.

7.5.2.1 Reservoir Impacts

In order to evaluate the potential loss of waterfowl production resulting from inundation of riverine habitat by the reservoirs, the habitat's capability for producing ducks must be determined.

As indicated in subsection 7.3.1, duck brood density observed along the Souris River ranged from 2.64 broods/km in 1984 to 6.25 broods/km in 1987. Brood density recorded along Moose Mountain Creek was 3.26 broods/km in 1987. The number of broods observed along the Souris in 1987 was 806; along Moose Mountain Creek, 78 were recorded. Using an average brood size of 4.9 from Cowardin and Johnson (1979), the annual production from the area to be impacted by the Rafferty Reservoir would be 3949 ducks, based on the 1987 data. Annual duck production from the area to be impacted by the Alameda Reservoir would be 382 birds. According to the 1987 data, then, a total of 4331 ducks could be lost annually due to inundation by the Rafferty and Alameda reservoirs (with no mitigation considered).

Total annual production from the reservoir areas could also be calculated using the number of breeding pairs observed in 1987. There were 1550 indicated breeding pairs observed in the Rafferty Reservoir area and 144 in the Alameda Reservoir area for a total of 1694 breeding pairs. Assuming that each adult bird produced 1.08 fledged young, the figure used during the

Garrison Diversion Unit and Burlington Dam studies, the total production would be 3659 birds annually.

There are a number of weaknesses inherent in using the brood and pair data collected in 1987 to estimate potential annual waterfowl production from the reservoirs. First, breeding pairs and broods were surveyed by walking the river and creek shorelines. Thus, only the ducklings that had succeeded in reaching the watercourse at the time of the surveys, and that were visible to the surveyors, were recorded. Some broods may have been concealed from view while others may have been located in upland habitat at the time of the surveys. Similarly, not all of the breeding pairs in the river and creek basins would be present along the shorelines; many dabbling ducks, especially, would have been located in upland habitat areas. Consequently, breeding pair and brood numbers could have been underestimated. Because Moose Mountain Creek occupies a deeply incised valley and does not include the extensive flood plain present along the Souris River, breeding pairs and broods are less likely to have been missed during the Alameda Reservoir surveys.

The second weakness was discussed by Young and Ludwig (1988a,b) in their reports. The surveys were conducted during a year of poor habitat conditions associated with below-normal precipitation. As discussed in subsection 7.3.1, and illustrated by Table 7.1, this resulted in substantially lower duck populations throughout southern Saskatchewan. Duck populations along the Souris River and Moose Mountain Creek may have reflected these depressed regional population levels. However, the opposite argument is also plausible - that poor habitat conditions (low pond numbers) in the off-river areas could have resulted in a higher proportion of ducks than normal being attracted to available waterbodies along the Souris and Moose Mountain Creek. The displacement of breeding waterfowl to the more stable habitat of the boreal forest and arctic tundra, when drought conditions exist in more southerly breeding ranges, is well known (Hochbaum *et al.* 1988). In addition, agricultural land practices combined with dry conditions force many upland nesting ducks to nest in the remaining "islands" of vegetative cover in an intensely cultivated landscape.

As a cross-check on the production figures calculated using the 1987 data, annual duck recruitment from the Rafferty Reservoir area was estimated using the **NAWMP** Computer Planning Tool (CPT). The CPT was developed to produce implementation plans for the **NAWMP** Prairie Joint Venture in order to meet waterfowl population objectives. It is based on the Cowardin mallard recruitment model (Johnson *et al.* 1987), developed at the U.S. Fish and Wildlife Service's Northern Prairie Wildlife Research Center in Jamestown, North Dakota. This model reflects our current understanding of breeding mallard biology in the prairie pothole region of Canada and the United States. The CPT is designed for use in a prairie pothole setting, and, therefore, may have only limited applicability to a riverine setting such as the Souris or Moose Mountain Creek. In addition, it is designed as a means for comparing different habitat management scenarios rather than producing precise estimates of duck production.

Areas of various vegetation cover types, calculated by Environmental Management Associates, were used as habitat inputs and long-term mallard densities, recorded in Stratum 35, were used as population inputs. In calculating the number of ducklings that might be produced from the specified area, the model takes into account such variables as wet versus dry years, nest success from different cover types, brood survival rate and fledging success. A more detailed explanation of how the CPT operates is beyond the scope of this document.

Using the CPT, the average annual number of fledged ducklings that might be produced from the Rafferty reservoir area and contributed to the fall flight was estimated as 1042 birds. This figure is significantly less than the estimate of 3949 ducks based on the 1987 data. At face value, it would appear that it is unlikely that the 3949 duck figure is an underestimate of the annual production. Considering the habitat types present in the reservoir area and current land management practices, it is more likely that the CPT has underestimated the number of ducks that are produced from this area.

Of the 4024.4 ha of land contained in the Rafferty Reservoir area, 1301.3 ha or 32 percent are contained in three community pastures (Estevan - Cambria, Midale and Lomond #1). Within the pasture land, 1012.5 ha or 78 percent were classified as either "native grass/shrub" (348.8 ha) or "native grass (dominant)/shrub" (663.7 ha) (D. Young, pers. comm.). These communities are comprised of varying proportions of shrub species (e.g. *Symphoricarpos* spp., *Rosa* spp., *Elaeagnus commutata*, *Juniperus* spp., *Prunus* spp.) graminoids and forbs. During their studies on mallard nest success and recruitment in prairie Canada, Greenwood *et al*. (1987) noted that, within native pastures, grass shrub habitat provided the most important nesting sites for mallards and other ducks. Duck nest density and mallard nest success were highest within contiguous blocks of native pasture which contained the largest tracts of grass in the areas studied. Greenwood *et al*. stated:

> "Large pastures not only allow ducks to space their nests widely, thereby possibly reducing the chance of detection by predators, but also may influence the makeup of the predator community. For instance, large pastures may afford protection to the coyote, a species that does well in the prairie environment, but that is vulnerable to human-inflicted mortality (Sargeant *et al*., 1987). The red fox is highly adapted to living in prairie, but where the two species are sympatric, coyotes tend to exclude red foxes from large blocks of habitat (Sargeant 1982, Sargeant *et al*., 1987). The red fox is probably the most serious predator on upland-nesting ducks in the prairie pothole region (Sargeant and Arnold 1984), and its absence is a benefit to nesting ducks. All of the large pastures in our study areas were occupied by coyotes and had few red foxes; however, red foxes were common in most areas of cropland."

In view of the findings of Greenwood et al. and the relative abundance of grass shrub habitat in the Rafferty Reservoir area, the number of broods observed in 1987, and the low estimate produced by the CPT, are not surprising. Taking all these considerations into account, there did not appear to be any rationale for either rejecting, reducing or inflating the annual production estimates obtained using the 1987 data.

Therefore, it was concluded that the average number of ducks which could be produced annually in the Rafferty and Alameda reservoir areas should be considered to be 4331 ducks. Should the Rafferty and Alameda dams be constructed, the direct loss to Saskatchewan through inundation of habitat could be 4331 ducks annually, less any residual production from the reservoirs.

Residual duck production from each reservoir was estimated by considering which shoreline segments might be suitable for brood rearing following impoundment. This consideration was guided by the results of waterfowl surveys carried out in Lake Diefenbaker in 1980 as part of the Grainland Power Project feasibility study (A. Didiuk, pers. comm.). Only one brood was observed along the entire length of shoreline surveyed. This was considered to be because Lake Diefenbaker shorelines offer little suitable habitat for brood rearing. The majority of the shoreline does not support emergent vegetation valuable as escape cover and as habitat for aquatic invertebrates necessary for duckling nourishment.

It is expected that much of the shorelines of the Rafferty and Alameda reservoirs will also not be suitable for the development of aquatic vegetation necessary for brood rearing due to the size of the reservoirs and erosion resulting from wave action, current, ice and associated bluff shedding processes. Shoreline erosion at Rafferty is expected to proceed at a rate of up to 1.75 m per year depending on exposure, slope and shoreline material (SBDA, pers. comm.). Over a span of 60 years, nearly vertical bluffs are expected to retreat between 5 and 65 m. Consequently, any aquatic vegetation which did succeed in becoming established would probably be limited to sheltered bays along former coulees and creek tributaries. However, even in areas which are less susceptible to erosion and slumping, vegetation establishment would be limited also by fluctuations in reservoir levels.

The lengths of those shorelines, which could be potentially suitable for vegetation establishment, were digitized for both reservoirs based on the Rafferty maximum flood level (MFL) of 554 m and the Alameda FSL of 562 m. The Rafferty MFL was selected in order to arrive at the maximum number of ducks that could be expected from Rafferty Reservoir. Environmental Management Associates conservatively predicted shoreline use to be 1.3 breeding pairs/km (D. Young, pers. comm.). Fledging rates were considered to be 2.55 ducklings/adult for the Rafferty Reservoir (3949 ducklings from 806 broods observed in 1987 / 1550 breeding pairs observed in 1987) and 2.65 duckling/adult for Alameda Reservoir (382 ducklings from 78 broods /144 breeding pairs).

Table 7.9 indicates that the Rafferty and Alameda reservoirs might be expected to produce 134 and 49 ducks annually, respectively, or a total of 183. Subtracting this residual duck production "gain" from the predicted loss estimate of 4331 ducks, yields a net direct loss to Saskatchewan of 4148 ducks (with no mitigation applied).

Table 7.9 Potential Duck Production from Rafferty and Alameda Reservoirs

Reservoir	Potential Suitable Shoreline (km)	Potential # of Breeding Pairs[a]	Potential Duck Production
Rafferty	40.4[b]	52.5	134[d]
Alameda	14.2[c]	18.5	49[e]
TOTAL	54.6	71.0	183

a based on 1.3 breeding pairs/km
b based on 554 m MFL
c based on 562 m FSL

d 52.5 X $\frac{3949}{1550}$

e 18.5 X $\frac{382}{144}$

7.5.2.2 Channelization Impacts

Some channelization of the Souris River downstream of Rafferty Dam would be required in order to accommodate expected flow releases from the Reservoir. This activity can be expected to be accompanied by a reduction in waterfowl production.

Approximately 16 km of river would be impacted by this activity. Using a conservative duck density of 5 breeding pairs/km and fledging rate of 1.08 ducklings/adult (used in the Burlington Dam study for this reach of the river), an estimated 173 ducks could be lost annually as a result of channelization.

7.5.2.3 Drainage Impacts

A major concern associated with the Project, voiced at the Rafferty-Alameda Board of Inquiry public hearings, is the fear that the existence of two large reservoirs could stimulate further drainage of wetlands by the agricultural community. A related concern is the fear that drainage of off-river wetlands might be encouraged in order to increase the supply of water to the reservoirs. In response to the latter concern, Premier Grant Devine has publicly stated, "I assure you that this will not be done. We will not look to these wetlands in order to fill the reservoirs" (Devine 1988).

Regarding the first concern, it has been estimated that there are approximately 16 200 ha of wetlands (6500 ha upstream of Rafferty Dam and 9700 ha in the Alameda area) that, from an engineering standpoint, could be drained and funded under the current Saskatchewan drainage policy (Ducks Unlimited, pers. comm.). Strengthening this concern is the fact that, currently, less than 5 to 10 percent of the drainage that actually occurs on a provincewide basis has the approval of the Sask Water (T. Moser, pers. comm.). In the case of the Souris Basin, the amount of approved drainage may be as little as 2 percent of the total drainage that takes place. It has been estimated that about 80 percent of the Souris Basin in Saskatchewan has been effectively drained already.

This problem has not been limited to Saskatchewan. The Souris-Red-Rainy Region Basin Commission estimated that less than half of the original wetland acreage in the basin remains (U.S. Army Corps of Engineers 1988). Before North Dakota passed the "no-net-loss" drainage Bill in 1987, wetland drainage in that state occurred at a rate of more than 8 to 12 thousand hectares per year (Jones 1988). Even with the State law in place, the potential still exists for further wetland drainage to occur since no permit is required for drainage of wetlands with less than a 32-ha (80-acre) watershed.

Of particular concern is the impact that wetland drainage, if allowed to continue, would have on the viability of the **NAWMP** in Saskatchewan. The **Saskatchewan Implementation Plan** was formulated on the basis of waterfowl habitat presently in place and seeks to increase duck population levels to those experienced in the 1970s by enhancing the availability of habitat through extensive and intensive land management techniques. Permitting further habitat destruction, through drainage for example, would seriously undermine this implementation plan. In Saskatchewan alone, $0.5 billion is to be spent through the **NAWMP** over a 15-year period, with 75 percent of the funds coming from U.S. sources, 10 percent from the federal government, 5 percent from organizations such as Wildlife Habitat Canada and Ducks Unlimited (Canada) and the balance (10 percent) provided by the province of Saskatchewan. Suggestions have been made by key **NAWMP** personnel that the present lack of soil and water conservation/management policies in Saskatchewan and the continued practice of promoting drainage in southern Saskatchewan could jeopardize the U.S. funding commitment to the **NAWMP** (Young 1989).

Rather than attempting to estimate the impact on waterfowl populations of drainage of off-river wetlands either directly or indirectly into the Rafferty and Alameda reservoirs, it is sufficient to state that such drainage would be extremely damaging, not only to prairie waterfowl in the short term, but to the long term success of the **NAWMP**. The province of Saskatchewan must take immediate steps to ensure that no further drainage occurs without full in-kind/acre-for-acre mitigation. The recently-released provincial Discussion Paper on Soil, Water, Wetlands (Young 1989) is encouraging in this respect.

7.5.2.4 Waterfowl Concentration Impacts

It is expected that many ducks and geese may be attracted to the Rafferty and Alameda reservoirs during fall staging and migration. Although very poor from a waterfowl production standpoint, Lake Diefenbaker was used by large numbers of waterfowl during the fall of 1980 (A. Didiuk, pers. comm.). As many as 17 000 waterfowl, mainly dabbling ducks and coots, were observed in early September. As well as ducks, the lake was also used by tundra swans, geese, grebes and loons. However, for some reason Boundary Reservoir is not frequented by staging waterfowl (D. Donald, pers. comm.).

Concentration of waterfowl, that would ordinarily be distributed over a much larger geographic area during fall staging, would result in a higher-than-normal harvest of that waterfowl population as hunting success would be enhanced. Increased hunting mortality would result in a reduction in the size of the breeding population returning the following spring. This would have the effect of eroding the baseline population upon which the **NAWMP** was based and would counteract population gains made through the **Saskatchewan Implementation Plan**.

A related but different concern is that the two reservoirs would likely short-stop waterfowl that, under existing conditions, frequent staging areas in North Dakota in the fall. Such a change in traditional migration patterns would adversely affect waterfowl hunting opportunities in North Dakota.

Rather than attempting to estimate the effect of increased hunting success near the reservoirs in Saskatchewan on waterfowl population levels, it is sufficient to state that appropriate steps, such as hunting restrictions, would have to be taken to ensure that hunter kill does not increase as a result of attraction of fall staging waterfowl to the reservoirs. The adverse effect of waterfowl short-stopping on hunting opportunities in North Dakota is difficult to quantify but could be significant.

Concentration of waterfowl into the Souris River basin may also be accompanied by crop damage in adjacent cultivated fields. Currently, virtually no crop damage occurs in the area, except in exceptionally poor harvest years on the Prairies. The value of crops reported lost within a 25 km radius over the period 1978-88 averaged less than $5,000 per year. No additional funds would be available from Canada for crop depredation prevention programs associated with the reservoirs. However, compensation for crop damage losses would be available.

7.5.2.5 Impacts on Moose Mountain Creek NWA

Moose Mountain Creek National Wildlife Area (NWA) is located on Moose Mountain Creek just upstream of Moose Mountain Lake. The possible impacts of filling and operating the Alameda reservoir on the ability to manage water levels within the NWA were considered. Due to the large distance between the NWA and the reservoir, and the existence of the dam at the downstream end of Moose Mountain Lake, it was concluded that the Alameda Dam and reservoir should have no adverse effect on the NWA.

7.5.2.6 Net Impacts in Saskatchewan

The annual net loss of waterfowl production in Saskatchewan, resulting from inundation of riverine habitat by the Rafferty and Alameda reservoirs and channelization downstream of Rafferty Dam, and without considering mitigation, could amount to 4321 ducks. This is equivalent to six percent of the estimated duck harvest (77 452) that occurred in Zone 3 (southeastern Saskatchewan) in 1987 (D. Caswell, pers. comm.). Expressed another way, this loss is equivalent to nine percent of the average number of breeding mallards expected to be produced annually (49 010) from the Moose Mountain Uplands key program area through the **Saskatchewan Implementation Plan** (Saskatchewan **NAWMP** Technical Committee, pers. comm.). The loss, then, is significant.

Off-river drainage into project works and increased waterfowl harvest at the reservoirs would increase this loss significantly if permitted to occur. As discussed previously, a portion of the direct loss of waterfowl production in Saskatchewan also represents an indirect loss to the United States.

7.5.3 North Dakota

With the Rafferty and Alameda dams in place, Saskatchewan would be able to retain 50 to 60 percent of the natural Souris River flow. The effect of these low flows on wetland habitat, management of the Upper Souris and J. Clark Salyer national wildlife refuges and waterfowl production has been evaluated by the U.S. Fish and Wildlife Service (U.S. Army Corps of Engineers 1988).

Low flow operations would negatively affect wetlands along the Souris River, particularly in the refuges. Reduction in water supply would make it difficult to maintain minimum water levels in the pools in J. Clark Salyer NWR and would accelerate the spread of noxious weeds and cattail throughout the refuge. An excessive spread of cattail would result in a loss of nesting, brood and post-breeding waterfowl habitat. Reduced water levels would make nesting islands vulnerable to predators. The incidence of avian botulism is expected to double.

It has been estimated that available migratory bird habitat would be reduced by about 65 to 95 percent throughout the migration and production periods during the years of most severe impact. The most serious impact is associated with delayed filling of the refuge pools and lack of breeding habitat. On average, waterfowl production is expected to decline by 40 percent at J. Clark Salyer NWR and by 50 percent at Upper Souris NWR. In most severe years of impact, production would be reduced by an average of 80 percent. The expected increased incidence of avian botulism would result in additional waterfowl production losses. While shorebirds may be favoured by exposed mudflats and shorelines as water levels recede, this value would be quickly diminished by establishment of emergent vegetation. Overall, marsh bird production is expected to experience the same decrease as waterfowl. Total use by migratory waterfowl and marsh birds is expected to decrease by 60 to 70 percent during the years of most severe shortages.

In flood years, higher than normal releases of floodwaters would occur over the summer months and into the fall and early winter. It appears that alteration of summer releases during flood events, while adversely affecting the ability to adhere to refuge management plans, would have a much less severe potential effect on refuge management than if the Lake Darling project, involving raising the level of Lake Darling by four feet, was implemented (U.S. Army Corps of Engineers 1988). Prolonged flows in the fall and early winter would have a somewhat greater impact on the ability to manage the refuges, particularly J. Clark Salyer NWR, for fall waterfowl staging use. However, low flows are of far greater concern than high flows due to their significant impact on waterfowl production.

The Lake Darling Task Force noted that, should carp succeed in surpassing the Wawanesa Dam in Manitoba, prolonged and increased flows over the fall and winter months during flood years could reduce fish winterkill probability and enhance the possibility of carp establishment in North Dakota (International Souris-Red Rivers Engineering Board 1984). The potential for destruction of waterfowl habitat in the Souris River NWRs by carp was described at length in the Burlington Dam Task Force report. Waterfowl habitat destruction would result in substantial losses (as high as 80 percent) of waterfowl production in the refuges. However, the Lake Darling Task Force concluded that, with or without the Lake Darling project, carp will eventually find their way past the Wawanesa Dam. This conclusion is considered to be valid in relation to the Project and, therefore, possible impacts on waterfowl production, as a result of habitat destruction by carp, were not estimated in this study.

In estimating the potential impacts of the Project on waterfowl production in North Dakota, a worse case reduction level of 80 percent was used. Average annual duck production at the Upper Souris NWR was considered to be 5000 based on data gathered over the period 1959-1978 by the U.S. Fish and Wildlife Service. Annual duck production at J. Clark Salyer NWR over the same period averaged 18 400 ducks. Average annual duck production along the Souris River was estimated during the Burlington Dam study to be 3880 ducks based on 5 breeding pairs/km of river and 1.08 fledged young/adult. Applying the 80 percent reduction rate to the total average annual production of 27 280 ducks, potential losses due to the Project, with no mitigation applied, are estimated to be 21 824 ducks annually. This loss figure may actually be conservative because it does not include duck mortality caused by increased botulism occurrence. In addition, in the most severe years, losses could be even higher because the 80 percent reduction value is considered to be an average figure by the U.S. Fish and Wildlife Service.

In the Garrison Diversion Unit study, it was estimated that 20 percent of the waterfowl production losses occurring in North Dakota would be experienced by Canada due to reduced contribution to the fall shuffle and international breeding reservoir. Therefore, the annual direct loss of 21 824 ducks in North Dakota due to the Project represents an annual indirect loss to Canada of 4365 ducks.

In subsection 7.5.2.4, it was indicated that a portion of the waterfowl flocks that, under present conditions, frequent various staging areas in North Dakota in the fall, are expected to be short-stopped by the Rafferty and Alameda reservoirs should the Project proceed. This would result in reduced opportunities for waterfowl hunting in North Dakota. While it is difficult to assess the magnitude of this impact, it could be significant.

7.5.4 Manitoba

With the Project in place, flow patterns downstream of the North Dakota-Manitoba boundary would be similar to those occurring downstream of Lake Darling in North Dakota. Flows would be less than currently experienced in some years and would be higher over the summer, fall and early winter in flood event years.

Flooding in Manitoba, resulting from higher than normal flows in some years with the Project in place, is expected to be restricted to the 10 km reach directly downstream of the border due to the low (4 m^3/s) channel capacity. Heavily-grazed pasture land is located along the river in this reach and, as a result, waterfowl production is very limited in this area. Therefore, it is unlikely that the Project would have any significant direct impact on waterfowl in Manitoba due to increased flows in some years.

The effect of Project-induced reduced flows in other years on waterfowl production is more difficult to determine. Information on the distribution of riparian and upland habitat types, and on the size and composition of the resident breeding waterfowl population, would be required in order to assess the impacts of low flows on waterfowl with confidence.

7.5.5 Summary of Impacts

Table 7.10 provides a summary of the impacts of the Project on waterfowl. Inundation of riverine habitat by the Rafferty and Alameda reservoirs is expected to result in an annual duck production loss of 4148 birds in Saskatchewan. This estimate takes into account a small number of ducks (183 ducks) that may be produced annually from habitat present in sheltered bays within the two reservoirs. Channelization downstream of the Rafferty Dam could result in a further loss of 173 ducks annually bringing the total average annual production loss in Saskatchewan to 4321 ducks. No mitigation was considered in making these calculations.

Table 7.10 Summary of Projected Impacts of the Project on Waterfowl

	Annual Loss of Ducks			
Type of Impact	Canada	North Dakota	Indirect Impacts on Canada	Total Impacts on Canada
Inundation of habitat (Saskatchewan)	4148[a]			4148
Channelization (Saskatchewan)	173			173
Low flows (North Dakota)		21 824	4365[b]	4365
TOTALS	4321	21 824	4365	8686

[a] includes residual annual reservoir production of 183 ducks

[b] 20 percent of North Dakota loss

Modified flow regimes in North Dakota are expected to have significant adverse effects on wetland habitat and management of the Upper Souris and J. Clark Salyer national wildlife refuges. Significant reductions in waterfowl production from the two refuges and along the Souris River are expected to occur. Total annual losses are expected to be as high as 21 824 ducks. This figure does not include the duck mortality resulting from the expected increase in avian botulism occurrence. As much as 20 percent of this loss, or 4365 ducks, could be felt indirectly in Canada, resulting in a total annual loss to Canada of 8686 ducks. This represents 18 percent of the average number of breeding mallards expected to be produced annually (49 010) from the Moose Mountain Uplands key program area through the **Saskatchewan Implementation Plan**.

The Project is not expected to have significant adverse effects on waterfowl production along the Souris River in Manitoba. Data on existing waterfowl habitat and present production is required in order to substantiate this expectation.

7.6 Mitigation

7.6.1 Mitigation

It is beyond the scope of this study to identify specific measures for mitigating the waterfowl production losses expected to occur as a result of the Project. Rather, this section describes the principles that should be applied in developing a mitigation package for the Project, should the Project go ahead.

Because of the fact that prairie duck populations are already at dangerously low levels and that Canada and the United States have made commitments through the **NAWMP** to restore continental duck populations to levels experienced in the 1970s, it is imperative that all waterfowl production losses associated with the Project in Canada and the United States are mitigated.

All waterfowl habitat lost or adversely affected as a result of the Project must be mitigated on the basis of in-kind/acre-for-acre replacement. This concurs with the decision of the Garrison Diversion Unit Commission on the Garrison Diversion Project and with the Ministerial Approval issued by the Saskatchewan Minister of Environment and Public Safety for the Project under the Environmental Assessment Act. This means that, in order to mitigate the expected waterfowl production losses stated above, enough replacement habitat would have to be acquired and managed in order to produce the same number of ducks that would be lost as a result of the Project. In this manner, no net loss of waterfowl production would occur as a result of the Project.

Appropriate steps would have to be taken to ensure that further wetland drainage in the Souris Basin is curtailed and that waterfowl harvest in the area surrounding the two reservoirs does not increase beyond present levels.

7.6.2 Monitoring

Should the Project go ahead, it would be necessary to monitor post-Project waterfowl production in order to determine whether the estimated waterfowl losses associated with the Project have been completely mitigated and that there has been no net loss of waterfowl production as a result of the Project.

In order to confirm that no further wetland drainage was occurring in the Souris Basin, a land use monitoring system would have to be put in place. This would probably involve acquiring aerial photographs of the Basin on a regular basis, ground surveys and follow-up to ensure compliance with the no-drainage restriction. In addition, monitoring of hunter success should be carried out at key waterfowl staging areas in North Dakota in order to determine the extent to which hunting opportunities were being reduced due to waterfowl short-stopping at the reservoirs in Canada.

Waterfowl harvest in the area surrounding the two reservoirs would have to be monitored in order to determine post-Project harvest levels and compliance with hunting restrictions and limits. This would involve bag checks at hunter checkpoints located at strategic points around the reservoirs.

8 FISH AND FISH HABITAT

8.1 Mandate

Under the Constitution Act (1982), the federal government has authority for all fisheries in Canada. In Saskatchewan and Manitoba (as well as four other provinces), federal fisheries legislation is administered by the provincial fisheries management agency, although provincial fisheries regulations must be promulgated by the federal government.

The Minister of Fisheries and Oceans has been assigned responsibility for sea coast and inland fisheries, marine science, and administration of the Fisheries Act. A key component of the Minister's overall responsibility for fisheries management is the protection of fish and fish habitat from disruptive and destructive activities. The Act allows for federal regulation and decision making respecting activities that could alter water flows or quality in a way that would harm fish. Under the Fish Habitat Management Policy (Canada Department of Fisheries and Oceans 1986) the Department of Fisheries and Oceans' long-term objective is the achievement of an overall net gain of the productive capacity of fish habitats. Fundamental to the habitat conservation goal is the 'no net loss' principle. Under this principle, the Department will strive to balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that further reductions to Canada's fisheries resources due to habitat loss or damage may be prevented. Both Saskatchewan and Manitoba endorse the principle of 'no net loss' of productive fish habitat.

8.2 The Existing Fishery Resources

8.2.1 Saskatchewan

The following description of the current state of the fishery resources and fish habitat of the Souris River Basin within the province of Saskatchewan is based upon information provided by Pierce and Blood (1977), EMA (1987), and Fernet (1988). The emphasis and focus of this section has been directed toward the Souris River mainstem between Weyburn and the international boundary, and the lower reaches of Moose Mountain Creek.

Available information indicates that Saskatchewan waters of the Souris River support at least 23 species of fish belonging to eight families (Table 8.1). Key species within the area for recreational fisheries are northern pike (Esox lucius), yellow perch (Perca flavescens), and walleye (Stizostedion vitreum). Although no quantitative estimate of the size of these populations is available, standing stocks appear to be low. The most widely distributed and abundant fish species are fathead minnow (Pimephales promelas), white sucker (Catostomus commersoni), and black bullhead (Ictalurus melas). No endangered fish species occur within the study area. Future sampling within the Souris basin may reveal additional species not yet reported as distributional maps suggest the possible presence of as many as 34 species (Scott and Crossman 1973).

Table 8.1 Scientific and Common Names of Fishes Reported from the Souris River Basin in Saskatchewan

		Occur In (+)[a]	
Family and Generic Name	Common Name	Souris R.	Moose Mtn Cr.
Family Esocidae			
Esox lucius Linnaeus	northern pike	+	+
Family Cyprinidae			
Hybognathus hankinsoni Hubbs	brassy minnow	+	
Notemigonus crysoleucas (Mitchill)	golden shiner	+	
Notropis atherinoides Rafinesque	emerald shiner	+	
Notropis blennius (Girard)	river shiner	+	
Notropis cornutus (Mitchill)	common shiner	+	+
Notropis stramineus (Cope)	sand shiner	+	+
Pimephales promelas Rafinesque	fathead minnow	+	+
Rhinichthys cataractae (Valencienne)	longnose dace	+	
Semotilus margarita (Cope)	pearl dace		+
Family Catostomidae			
Catostomus commersoni (Lacepede)	white sucker	+	+
Family Ictaluridae			
Ictalurus melas (Rafinesque)	black bullhead	+	+
Ictalurus nebulosus (Lesueur)	brown bullhead	+	
Noturus gyrinus (Mitchill)	tadpole madtom	+	
Family Gasterosteidae			
Culaea inconstans (Kirtland)	brook stickleback	+	+
Pungitius pungitius (Linnaeus)	ninespine stickleback		+
Family Percopsidae			
Percopsis omiscomaycus (Walbaum)	trout perch	+	+
Family Centrarchidae			
Micropterus salmoides (Lacepede)	largemouth bass	b	
Family Percidae			
Perca flavescens (Mitchill)	yellow perch	+	+
Stizostedion v. vitreum (Mitchill)	walleye	+	+
Etheostoma exile (Girard)	Iowa darter	+	+
Etheostoma nigrum Rafinesque	johnny darter	+	+
Percina maculata (Girard)	blackside darter	+	+

a Presence noted by Scott and Crossman (1973).

b Introduced Species - Distribution in Souris Basin restricted to Boundary Dam reservoir.

8.2.1.1 Distribution and Relative Abundance

In general, species diversity varies with habitat diversity and appears to be greater in downstream areas of the Souris system. Man-made barriers to fish movement play an important role in determining the extent of fish movement through the watershed. Distribution and relative abundance are discussed below in relation to the location of the proposed Rafferty and Alameda dam sites on the Souris River and Moose Mountain Creek, respectively (Tables 8.2 and 8.3).

Table 8.2 Distribution of Fish Species Within the Souris River Mainstem Downstream of Weyburn

Species	River Reach[a]				
	1	2	3	4	5
Northern pike	+	+	+	+	+
Brassy minnow					+
Golden shiner					+
Emerald shiner				+	
River shiner					+
Common shiner	+	+	+	+	+
Sand shiner		+		+	
Fathead minnow	+	+	+	+	+
Longnose dace				+	+
Pearl dace					
White sucker	+	+	+	+	+
Black bullhead		+	+	+	+
Brown bullhead					
Tadpole madtom			+		+
Brook stickleback	+		+	+	
Ninespine stickleback					
Trout-perch	+	+	+		+
Largemouth bass					
Iowa darter					+
Johnny darter				+	+
Yellow perch	+	+	+	+	+
Blackside darter				+	+
Walleye	+	+	+	+	+

[a] Reach 1: From Weyburn down to proposed FSL.
2: From proposed FSL to proposed Rafferty Dam site.
3: From proposed Rafferty Dam site to Estevan Dam.
4: From Estevan Dam to Oxbow weir.
5: From Oxbow weir to U.S. border.

Table 8.3 Distribution of Fish Species Within Moose Mountain Creek

Species	River Reach[a]		
	1	2	3
Northern pike		+	+
Brassy minnow			
Golden shiner			
Emerald shiner			
River shiner			
Common shiner	+		+
Sand shiner			+
Fathead minnow	+	+	+
Longnose dace			
Pearl dace	+		
White sucker	+	+	+
Black bullhead		+	+
Brown bullhead			
Tadpole madtom			
Brook stickleback	+	+	+
Ninespine stickleback	+		
Trout-perch	+		
Largemouth bass			
Iowa darter		+	+
Johnny darter	+	+	+
Yellow perch	+		
Blackside darter			+
Walleye			+

[a] Reach 1: Upper watershed.
2: Area of proposed Alameda Reservoir.
3: From proposed Alameda Dam site to confluence with Souris River.

Souris River

Reach 1: Upstream of Full Supply Level

This reach includes Nickle Lake, an onstream storage reservoir with an area of 445 ha and a mean depth of 9.0 m. Game fish present in the lake include yellow perch and northern pike which maintain permanent self-sustaining populations. Walleye are apparently unable to survive the low winter oxygen levels in the reservoir and the population must be maintained by stocking. White suckers are abundant in Nickle Lake, providing adequate forage for the game fish species. Other species documented to occur within this reach include common shiner (*Notropis cornutus*), fathead minnow, brook stickleback (Culea inconstans), and trout-perch (Percopsis omiscomaycus). The Nickle Lake Dam creates a barrier to fish movements within this reach. Upstream of Weyburn, the Souris River is an intermittent stream and supports no permanent fish populations.

Reach 2: Proposed Rafferty Reservoir at FSL

This reach is continuous with Reach 1 and similar to it in terms of habitat conditions. From the Nickle Lake Dam downstream to the proposed Rafferty site, the Souris River is a slow-moving, meandering, prairie river which ranges in width from 10 to 30 m, and has depths up to 4 to 5 m in a U-shaped river channel. River substrate is primarily silt with gravel and cobble occurring in a few riffles. Dead Lake, an offstream storage reservoir, is located near the upstream end of the reach. The Dead Lake Dam creates a barrier to fish passage within the reach during most times of the year. Two major tributaries, Roughbark Creek and Jewel Creek enter the Souris mainstem at the extreme upstream end of the reach.

With respect to game species, the situation in Dead Lake is similar to that in Nickle Lake. Pike and yellow perch populations are maintained by natural reproduction, but the existence of walleye depends on regular stocking. These fish can move freely from Dead Lake up to the Nickle Lake Dam, below which all three species are regularly caught. The lower reaches of Roughbark and Jewel creeks are used as spawning areas for northern pike and yellow perch of this reach. Species documented in the proposed reservoir area that were not captured in Reach 1 include sand shiner (Notropis stramineus) and black bullhead, while brook stickleback were not reported from Reach 2.

Reach 3: Proposed Rafferty Dam Site to Estevan Powerhouse Dam

There is currently no restriction of fish movement between Reach 2 and Reach 3, and the proposed Rafferty dam is the reason for creating a separate reach for the purpose of this analysis. Ten fish species have been reported from this section of the river (Table 8.2). Of this number, only tadpole madtom (Noturus gyrinus) has not been reported upstream.

The large dam at the downstream end of Reach 3 represents a total barrier to upstream migration except in extreme high-flow situations such as occurred in 1976. Downstream movements over the dam are possible only in spring or during other high-flow events.

A limited amount of northern pike spawning habitat is present in this reach but access to it has been restricted by spring backflood irrigation projects used to stimulate hay production on the valley bottom. Suitable spawning habitat for yellow perch occurs in several areas but utilization of these sites is apparently limited. Spawning habitat for black bullheads, fathead minnows, and brook sticklebacks is abundant here and recruitment was successful in 1987, a low flow year. Little spawning habitat for white suckers occurs in Reach 3 and the suckers observed in this section are thought to have originated from upstream of the proposed Rafferty Dam site. The Woodlawn Park Weir restricts fish movements within Reach 3 to high-flow periods but produces depths suitable for summer rearing and overwintering of the fish species found within this reach.

Reach 4: From Estevan Power House Dam to Oxbow Weir

The species diversity observed in this reach is greater than occurs upstream reflecting the increased habitat diversity present. A total of 13 fish species have been documented within this river section including four; emerald shiner (Notropis atherinoides), longnose dace (Rhinichthys cataractae), johnny darter (Etheostoma nigrum), and blackside darter (Percina maculata) that have not been reported from upstream areas. One species, tadpole madtom, was not recorded in Reach 4 although it has been reported both from upstream and downstream of this area (Table 8.2).

The substrate in Reach 4 includes some riffle areas over cobble and gravel as well as the more common pool and slow-water habitats. The abundance of all three sport species (walleye, northern pike and perch) in Reach 4 was low in 1987. Juvenile perch and pike, but no young-of-the-year, were taken. Only adult walleye occurred in samples from this reach. Black bullheads, fathead minnows, and white suckers were the dominant fish species in this portion of the Souris River and all appear to spawn successfully here.

Although Reach 4 contains numerous small blockages that restrict fish movements within it, these blockages produce pools that may be suitable for overwintering fish. Fish from this reach have free access to Moose Mountain Creek which enters the Souris mainstem near Oxbow. The large weirs at the upper and lower ends of Reach 4 prevent fish from migrating upstream out of the reach or from entering it at the downstream end except under extreme high water conditions.

Reach 5: From Oxbow Weir to International Boundary

This reach of the Souris River contains the greatest diversity of fish species in the study areas because of improved water quality and increased habitat diversity. A total of 16 species have been recorded in Reach 5, four of which; brassy minnow (Hyboghathus hankinsoni), golden shiner (Notemigonus crysoleucas), river shiner (Notropis blennius), and Iowa darter (Etheostoma exile), have not appeared in samples taken upstream in the Souris River mainstem. Of species that do occur in upstream areas, three have not been reported from Reach 5, including emerald shiner, sand shiner, and brook stickleback (Table 8.2).

Between the Oxbow Weir and the international boundary, the Souris River is generally shallow with areas of sand, gravel, and cobble producing clear riffle and shallow pool habitat. Upstream movement is restricted by the presence of the Oxbow Weir, but otherwise movement within this reach is impeded only occasionally by several culverted low-level crossings.

Movement of fish over the Oxbow Weir from upstream may occur during periods of high water.

Yellow perch and northern pike are common downstream of the Oxbow Weir where deep water provides suitable rearing and overwintering habitat. Spawning habitat for pike and perch is very limited within this portion of the river. The most abundant fish species in Reach 5 are white suckers, fathead minnows, black bullheads, and river shiner, all of which spawn successfully in this area as large numbers of fry and juveniles were captured. Although occurring in smaller numbers, longnose dace, the shiner species, darter species, trout-perch, brassy minnows, and tadpole madtoms all reproduce and rear within Reach 5. The extent to which fish from North Dakota migrate into this section of the Souris River is not known, but such movements undoubtedly occur.

Moose Mountain Creek

Reach 1: The Upper Watershed

Moose Mountain Creek arises north of Moose Mountain Lake. It is characterized by a wide marsh in the upper reaches of the river valley and is fed by numerous springs which contribute to a relatively high water quality in the stream. The creek substrate in this area consists of sand and gravel. Moose Mountain Lake is a relatively large (525 ha), and shallow (mean depth 2.2 m) water body with emergent vegetation in some bays. Nutrient levels in the lake are relatively high and significant algae blooms occur in the lake during the summer (Wallin 1980). Critically low dissolved oxygen levels can occur during the winter. Northern pike and yellow perch have been stocked in Moose Mountain Lake and a large population of white sucker is also present. Other fish species reported to occur in these upper reaches of Moose Mountain Creek include common shiner, fathead minnow, pearl dace, brook stickleback, ninespine stickleback, trout-perch, and johnny darter (Table 8.3).

Reach 2: Proposed Alameda Reservoir

The section of Moose Mountain Creek from full supply level (FSL) at the upstream end of the proposed Alameda Reservoir to the confluence with the Souris River can be considered to consist of one habitat type. Currently, therefore, one might expect to observe the same diversity of species in Reach 2 as below the proposed dam site. The fish community of this area should resemble closely that observed in Reach 4 of the mainstem Souris River.

From the upper end of the proposed reservoir to Oxbow, the stream substrate is silt in pool areas and cobble/boulder in riffles. Gravel bars are relatively common.

Only seven species of fish have been reported to date from Reach 2 of this tributary (Table 8.3), probably reflecting the low level of sampling effort. Northern pike is the only game fish reported in this reach but little spawning habitat is present, and no fry or juveniles were reported. Of the remaining species captured in Reach 2, white suckers, black bullheads, brook sticklebacks, and fathead minnows were all abundant and widely distributed. Iowa darters and johnny darters were present but in lower numbers. Overwintering opportunities within the section are limited to deeper pools. No notable barriers to fish movement occur in Reach 2 of Moose Mountain Creek.

Reach 3: Proposed Alameda Dam Site to Souris River Confluence

This 4 km long reach is deeper and wider than Reach 2 and consists of a series of long, deep pools connected by short, cobble/boulder riffles. A total of 11 fish species have been reported from this reach (Table 8.3), including northern pike and walleye. White suckers, black bullheads, brook stickleback, and fathead minnows are as abundant here as in Reach 2 but johnny and Iowa darters were more abundant in Reach 3. Reach 3 appears to offer superior overwintering and rearing conditions than occur in Reach 2.

A concrete railway culvert located mid-way along Reach 3 may have high water velocities during moderate and high creek stages. Otherwise, no significant impediments to fish migration occur within Reach 3.

8.2.1.2 Factors Affecting Populations

The maintenance of healthy and productive fish populations requires the provision of suitable habitat conditions at the appropriate time. Specific habitat requirements differ between species and between life history stages of the same species, but involve such things as spawning conditions (substrate, water depth, water temperature), water quality (temperature, pH, dissolved oxygen, dissolved and suspended sediments), overwintering habitat, water quantity, and food supply.

The quality of the existing habitat can sometimes be inferred from observations of the fish populations. For example, the abundance and widespread distribution of fathead minnow, white suckers, and black bullheads implies that the Souris River Basin provides excellent habitat conditions for these species. On the other hand, walleye are more restricted in their distribution, are often subject to winterkill, and must be stocked regularly. Because walleye are unable to thrive in this watershed, it is apparent that several of their habitat requirements are not met within this system. Relatively slow growth rates for northern pike and yellow perch from the Souris River also suggest less than optimal growing conditions for these important recreational fish species.

Fernet (1988) attempted to evaluate the suitability of existing habitats within the lower Souris River and Moose Mountain Creek for northern pike and walleye through the use of Habitat Evaluation Procedures (HEP) models (U.S. Fish and Wildlife Service, 1980). Results indicate that the habitat in question is not suitable for northern pike production during moderate or high flow years because, in such years, rapidly falling water levels after the spawning period could result in the destruction of eggs or the stranding and death of newly emerged young.

During low-flow years, the Souris River immediately below the proposed Rafferty Dam site also exhibited low habitat suitability for pike. In this case, however, the limiting factor was determined to be high total dissolved solids (TDS) values (1007 mg/L). TDS concentrations greater than 800 mg/L are thought to cause osmoregulatory stress in northern pike (Inskip 1982). Further downstream within the Souris River, as well as in Moose Mountain Creek, where improved flow conditions preclude such high TDS levels, habitat suitability improves significantly during low flow years.

The application of similar methods to walleye revealed that potential walleye productivity in Moose Mountain Creek was low during moderate flow years and nil during high and low water years. In the Souris River downstream of the Moose Mountain Creek confluence, suitable spawning habitat for this species is non-existent in moderate and high flow years but a small amount is present during low water years. The limiting factors in the model were the amount of suitable riffle habitat where appropriate water depths were present, and the maintenance of constant water levels during the incubation period.

A major problem within the Souris River system involves the segmentation of the river by the construction of man-made barriers. Currently, numerous such barriers exist, ranging in size from low-level earth or rock weirs that are readily traversed by fish only in spring or during other high-water events, to dams several metres high which block all upstream fish migrations in all but the most extreme flood conditions.

In very high-water years, fish movements through much of the Souris Basin may be unrestricted permitting wide dispersals into areas usually isolated by barriers. During subsequent low water years, which represent the more usual case, such fish may become trapped in isolated pools and be subjected to summerkill, winterkill, and/or angling pressure.

The area currently most affected by barriers is that portion of the Souris River mainstem downstream of the proposed Rafferty Dam site. The Estevan Power House Dam downstream of the Long Creek confluence effectively blocks all upstream migrations, thus the section of the Souris River upstream of the proposed Rafferty Dam site must depend upon its existing fish population to sustain itself. Similarly, the Oxbow Weir prevents all upstream migration from downstream except in the most severe flood conditions.

Between the Estevan Power House Dam and the Oxbow Weir, there are also numerous smaller blockages to fish passage. These restrict fish movements within this area under low-water conditions but also create pools on their upstream sides that may be suitable for overwintering. Effectively, fish occupying the area between these two major barriers are isolated. They can move within that reach with some restriction, or they can migrate up into Moose Mountain Creek.

8.2.1.3 Recreational Fisheries

A 1980 survey of recreational fishing in Saskatchewan (Murray et al. 1984) reported that 80 percent of the recreational fishing activity conducted by Saskatchewan residents occurs in the southern half of the province. Within the southern region 91 percent of the angling effort is exerted by residents, who account for 87 percent of all anglers. Surveys indicate that within the Souris River Basin, recreational fishing pressure is exerted almost exclusively by local residents.

Although recreational fishing occurs throughout the Saskatchewan portion of the Souris Basin, the major effort appears to be concentrated in a few locations, including Nickle Lake, Dr. Mainprize Regional Park, Dead Lake, and Woodlawn Park near Estevan, all of which are located on the Souris River mainstem. Moose Mountain Lake, in the upper reaches of Moose Mountain Creek, is also a popular angling lake for local people. Apparently little recreational fishing occurs in the lower reaches of Moose Mountain Creek except in the spring of the year when the fish are running. At that time, increased angling pressure is also exerted on the Souris River near the confluence of Moose Mountain Creek and near the weir at Oxbow, although pressure is still relatively light here.

Throughout the basin, walleye is the species preferred by anglers, although it is limited in distribution and abundance and contributes only a small proportion of the catch. Walleye are taken in Nickle Lake, Dead Lake, and the Boundary Dam Reservoir, all of which are stocked. They are also angled near Roche Percée and Oxbow in the Souris, at the railway crossing on Moose Mountain Creek, and in the larger lakes of the Moose Mountain uplands.

Northern pike are angled along the entire length of the Souris River mainstem. This species accounts for about 15 percent of the anglers creel during the open water period and is the dominant species in winter catches. Yellow perch is the most abundant game fish in the basin and forms the bulk of anglers' catches.

Angler opinion of the quality of recreational fishing along the Souris River ranges from poor to good, and varies according to location and time of year. In most locations, angling appears to be most popular in spring and early summer, at which time the targetted species are northern pike and walleye which are migrating within the system. In summer, after flows have decreased, anglers report fair to good success in pools where northern pike are stranded. A few locations, such as Nickle Lake, Dr. Mainprize Regional Park, and Dead Lake, remain popular year round and support substantial winter fisheries. Ice fishing also occurs in Moose Mountain Lake (Wallin 1984).

Black bullheads are taken occasionally by anglers. Although abundant in the Souris basin, this species is not held in high regard by local anglers.

A special situation of note occurs within the Boundary Dam Reservoir where stocking in 1983 and 1984 has resulted in the establishment of a "sensational" fishery for largemouth bass. Since the initial stocking, fish of 2.3 to 2.7 kg have been taken, natural spawning has occurred, and the fishery has become a major attraction for Estevan residents. The absence of suitable habitat has prevented these fish from establishing beyond the limits of the reservoir.

8.2.2 North Dakota

The following description of the current state of the fishery resources and fish habitat of the Souris River within the State of North Dakota is based upon information provided in the U.S. Army Corps of Engineers EIS (1988).

In North Dakota, two U.S. Fish and Wildlife Service national wildife refuges, the Upper Souris NWR and the J. Clark Salyer NWR, impound extensive reaches of the Souris River. The U.S. FWS-owned Lake Darling Dam in the Upper Souris NWR was built in the 1930s and creates the largest reservoir. Its purpose is to supply water to downstream impoundments in both refuges. It has also been operated to provide some flood storage during spring runoff as a matter of cooperation with local interests.

The 577 km Souris River loop in the United States provides habitat for 28 species representing eight families. Fish species found in the Souris River and Lake Darling are characteristic of those found in warm to cool rivers in the upper midwest of the United States. Northern pike, walleye and yellow perch are very common and are the principal sport fish. White sucker, black bullhead, brown bullhead (Ictalurus nebulosus), and fathead minnow are the most common forage species.

Aquatic habitat occurs in three distinct types - lake, riverine, and marsh. Lake Darling provides the bulk of the lake habitat and the Souris River the riverine. The majority of the marsh habitat is found in J. Clark Salyer NWR, the upper reaches of Lake Darling, and along the stretch of river below Lake Darling Dam to Baker Bridge.

Lake Darling

Lake Darling is classified by the North Dakota State Department of Health and Consolidated Laboratories as a Class 2-C cool water fishery, capable of supporting growth and propagation of non-salmonid fishes and associated aquatic life. The C-class characteristic (present degree of eutrophication) applies to a lake that is somewhat degraded and is progressing toward further degradation. The reservoir is shallow and has a consistent pattern of weak and intermittent thermal stratification for the month of May through August.

Lake Darling is nutrient rich and currently experiences intense algal blooms during the summer. These blooms are composed almost entirely of the blue-green alga _Aphanizomenon_ _flos-aquae_. Die-offs of algal blooms exert high demand on dissolved oxygen and can cause the deeper areas of the lake to become anoxic. Low dissolved oxygen conditions have been a problem in the past in Lake Darling, especially during winters that have a combination of factors such as high nutrient levels, high aquatic plant growth, low water levels, heavy snow cover, cloudy ice, and long periods of ice cover. Major winterkills in Lake Darling occurred in 1946, 1960, 1967 and 1978, but localized anoxic conditions and minor fish kills probably occur during most winters in at least portions of the Souris River in North Dakota. Following major winterkills, 3 to 5 years of stocking recovery are necessary to return to an excellent sport fishery.

At present northern pike, walleye, and yellow perch all reproduce naturally in the lake; in addition, walleye and northern pike are supported by stocking. Since 1978, 1.5 million northern pike, 2.5 million walleye, 14 000 yellow perch, and 200 000 smallmouth bass have been stocked in the lake. The effort to establish a smallmouth bass fishery in Lake Darling is showing good promise and several fish in the 1.4 kg class have been caught by anglers in recent years. Continual stocking and monitoring of this species is planned. An excellent base of several forage species exists in the lake.

In Lake Darling the natural process of sedimentation will continue to reduce the volume and mean depth of the lake. The current projected sedimentation rate is approximately 30 cm every fifty years. Estimates based on the sedimentation rate in Lake Darling are that over the next 100 years the volume will be reduced by about 20 percent. The loss of storage contributes to the dissolved oxygen problems especially during the late winter months. As a result, the value of Lake Darling as a fishery resource is expected to decline naturally over the next 100 years. This is based upon the expectation that winterkill will become more of a management problem as time passes. Long-term fisheries management will require consideration of gradual reduction in capacity due to factors such as sedimentation. Management personnel at the Upper Souris NWR have indicated that if water levels in Lake Darling are above elevation 485.55 m (the 50/50 triggering elevation), winterkill conditions will generally not develop. They have observed that when water levels are below 485.24 m the lake becomes susceptible to winterkill if the other factors discussed earlier prevail.

During the period 1942-86 water levels in Lake Darling during February (most critical time of year) were at or below 485.24 m about 38 percent of the time (17 out of 45 years). Years of documented winterkill correlate to some degree with years of low water, but not entirely. This reinforces the belief that low water levels alone do not cause winterkill, they only make the lake more susceptible to winterkill.

Historically, fish kills in Lake Darling have occurred in approximately nine percent of the years or roughly 1 out of every 11 years. To better judge past and future fish kill probabilities, however, one must consider that in years following severe fish kills, fewer but more tolerant fish remained, thus given average conditions, a lesser chance of a repeat kill would result.

The North Dakota Game and Fish Department (U.S. Army Corps of Engineers 1988) has indicated that if the winterkill recurrence frequency increased to once every seven or eight years fisheries management could continue to provide a viable fishery through restocking efforts. Fishing has been excellent in Lake Darling whenever there were long periods with water above 485.24 m on December 31. Generally, these periods occurred in the 1950s, late 1960s, mid 1970s and the mid 1980s.

Angler use of Lake Darling was estimated at 27 348 angler-days in 1974-75. In the winter of 1979-80 ice-angler use for a three-month period was estimated at 1138 angler-days. A creel survey during the summer of 1983 estimated use for May through September at 11 335 angler-days with an estimated harvest of over 2700 kg of walleye. The North Dakota Game and Fish Department (U.S. Army Corps of Engineers 1988) estimates that in 1984/85 Lake Darling received over 113 000 angler use-days, 3.5 percent of all State fishing recreation. Sixty-six percent of the harvest from Lake Darling is comprised of northern pike, followed by smaller percentages of walleye, yellow perch, and smallmouth bass.

Souris River

The Souris River is rated by North Dakota State Department of Health and Consolidated Laboratories as a Class 1-A river (highest State category), suitable for the propagation of resident fish species. Flows are variable, with flood flows generally occurring in April or early May. Low flows at the border generally occur from late summer through fall and winter. Periods of no flow lasting from days to weeks at a time are common at Sherwood. Below Lake Darling Dam, the flows are regulated for water supply purposes.

The Souris River supports the same type of fishery in terms of species as Lake Darling. Spawning habitat for walleye in the riverine areas is limited to areas below low-head dams and isolated gravel-rubble riprap deposits. J. Clark Salyer NWR has extremely good northern pike spawning conditions, but winterkill in these shallow impoundments severely limits fish management. Other reaches of the Souris River suffer occasional winterkill because of low flows and impaired water quality. The Souris River fishery is almost totally dependent upon fish escaping from Lake Darling for repopulation.

In 1983 the U.S. FWS conducted an aerial survey of angler use on 440 km of the Souris River below Lake Darling between 1 May and 3 September. Seventy-four percent of the observed use occurred between Lake Darling Dam and Minot; 5 percent from Minot to Towner; and 21 percent from Towner to Westhope. A total of approximately 2022 angler-days of use was projected for the survey period. Considering the size of the area surveyed, angler use was relatively low. A 1974/75 survey projected angler-day use for the same river stretch at 19 650.

Outside of the Missouri and Red river systems, the Souris River system is the most heavily utilized river fishery in North Dakota and by far the largest, most important fishery in the northwestern quarter of the state. Overall, the two U.S. FWS refuges accounted for approximately 78 225 fisherman visits in 1987. This important recreational fishery is valued at approximately four million dollars per year to the local economy.

8.2.3 Manitoba

The following description of the current state of the fishery resources and fish habitat in Manitoba is based on Neilson (1976), and Neilson (1977).

Available information indicates that Manitoba waters of the Souris River support at least thirty-eight species of fish belonging to thirteen families (Table 8.4). Distributional maps (Scott and Crossman, 1973) suggest the possible presence of as many as forty-six species and no endangered fish species occur within the area.

In the lower reaches of the Souris River a rather rich and diverse fauna is found relative to the upper reaches which are relatively depauperate. Northern pike is the only game species which is ubiquitous to the basin in Manitoba. The walleye, an important game species, is limited almost entirely to the lower reaches of the river below the town of Souris. Members of the family Hiodontidae (goldeye and mooneye) do not seem to go further upstream than the Wawanesa Dam. The same applies to carp, freshwater drum (Aplodinotus grunniens) and rock bass (Ambloplites rupestris), all of which are taken occasionally below Wawanesa. The white sucker is quite common throughout the river, with the shorthead redhorse sucker (Moxostoma macrolepidotum) found most frequently below the town of Souris to the confluence with the Assiniboine River. Carp have been found upstream of the Wawanesa Dam and in North Dakota but all occurrences can be related to the 1949 washout of the Wawanesa Dam which was not rebuilt until 1951 (W. Howard, pers. comm.).

The mobility of fish found in the Souris River in Manitoba is an important determining factor in distribution of a given species. Often, the low-head dams located at Wawanesa and Souris act as complete barriers to upstream migration. The Wawanesa Dam, a 3.66 m high concrete weir is the most formidable barrier migrating fish must overcome. Each spring, upstream migrants from the lower reaches of the Souris River and possibly the Assiniboine River attempt to pass this dam. During years of exceptionally high spring runoff (e.g., 1976) upstream spawning migrants are able to swim around the dam in the flooded area. The 2.13 m high concrete weir at Souris does not constitute as great a barrier to upstream movement as the Wawanesa Dam. Four other stop-log dams on the river, located at Napinka, Hartney and Melita (two), generally do not interfere with fish movement upstream since the stop-logs are often removed prior to spring run-off.

Table 8.4 Scientific and Common Names of Fishes Reported from the Souris River Basin in Manitoba

Family and Generic Name	Common Name
Family Petromyzontidae	
Ichthyomyzon castaneus Girard	chestnut lamprey
Family Esocidae	
Esox lucius Linnaeus	northern pike
Family Cyprinidae	
Hybognathus hankinsoni Hubbs	brassy minnow
Notropis dorsolis (Agassiz)	bigmouth shiner
Notropis hudsonius (Clinton)	spottail shiner
Notropis atherinoides Rafinesque	emerald shiner
Notropis blennius (Girard)	river shiner
Notropis cornutus (Mitchill)	common shiner
Notropis stramineus (Cope)	sand shiner
Notropis heterolepis Eigenmann and Eigenmann	blacknose shiner
Notropis hetersodon (Cope)	backchin shiner
Pimephales promelas Rafinesque	fathead minnow
Rhinichthys cataractae (Cope)	longnose dace
Rhinichthys atratulus (Hermann)	backnose dace
Semotilus margarita (Cope)	pearl dace
Semotilus atromaculatus (Mitchill)	creek chub
Hybopsis gracilis (Richardson)	flathead chub
Cyprinus carpio Linnaeus	carp
Family Catostomidae	
Catostomus commersoni (Lacepede)	white sucker
Moxostoma macrolepidotum (Lesueur)	shorthead redhorse
Family Ictaluridae	
Ictalurus melas (Rafinesque)	black bullhead
Ictalurus nebulosus (Lesueur)	brown bullhead
Noturus gyrinus (Mitchill)	tadpole madtom
Family Centrarchidae	
Ambloplites rupestris (Rafinesque)	rock bass
Microptesus dolomieui (Lacépède)	smallmouth bass
Family Sciaenidae	
Aplodinotus grunniens (Rafinesque)	freshwater drum

Table 8.4 Scientific and Common Names of Fishes Reported from the Souris River Basin in Manitoba (continued)

Family and Generic Name	Common Name
Family Gasterosteidae	
Culaea inconstans (Kirtland)	brook stickleback
Pungitius pungitius (Linnaeus)	ninespine stickleback
Family Pereopsidae	
Percopsis omiscomaycus (Walbaum)	trout perch
Family Percidae	
Perca flavescens (Mitchill)	yellow perch
Stizostedion v. vitreum (Mitchill)	walleye
Stizostedion canadense (Smith)	sauger
Etheostoma exile (Girard)	Iowa darter
Etheostoma nigrum Rafinesque	johnny darter
Percina maculata (Girard)	blackside darter
Family Gadidae	
Lota lota (Linnaeus)	burbot
Family Hiodontidae	
Hiodon alosoides (Rafinesque)	goldeye
Family Salmonidae	
Coregonus clupeaformis (Mitchill)	lake whitefish

However, in years of low water, they may block the movement of fish downstream to more suitable wintering areas.

Since dams on the Souris River essentially preclude upstream fish movements in most years, recruitment to fish populations in the system is dependent primarily on upstream sources. Under existing conditions, Lake Darling may be responsible in part for the continued presence of fish populations in the J. Clark Salyer refuges and the upper Souris River in Manitoba.

The best spawning habitat for walleye is found downstream from the town of Souris. In this section of the river, there is a fairly high incidence of riffle areas, below which walleye might spawn. However, upstream from the town little spawning habitat exists for this species. The situation is exactly the opposite when the spawning requirements of northern pike and yellow perch are considered. It is clear that the bulk of dependable pike spawning areas occur well upstream from the town of Souris. In this reach, the river has a lower gradient and the frequency of meanders and channel remnants increases. The channel flow capacity is also considerably less, particularly near the U.S. boundary. When the flow in this section of the river exceeds roughly 4.24 m^3/s, the channel capacity is exceeded in several locations and previously isolated oxbows and other channel remnants may become flooded. Such flooded areas supply potential spawning grounds for both northern pike and yellow perch.

The Cyprinidae (minnows) as a group are the most important forage species found in the Souris River. Their spawning requirements would seem to be met adequately at the present. However, the drastic annual flow fluctuations so common to the Souris River do not favour the establishment of rooted aquatic plants, or any other type of shelter for cyprinids.

Limited flow, high summer water temperature and low dissolved oxygen levels are presently some of the factors limiting fish production in Manitoba portions of the Souris River. The Souris River is eutrophic and subject to algal blooms. Runoff through the fertile Souris River watershed readily picks up nitrogen and phosphorus which is carried out on eroded particulate matter. In the summer, oxygen may become a limiting factor when algal blooms "collapse" and decompose, depleting dissolved oxygen in the process. As well under conditions of low flow during a hot summer, the temperature tolerance of the species under consideration becomes of importance. In average years, low flow levels throughout the ice-free season preclude the system from providing adequate fish habitat. Low flows force fish to concentrate in deep pools where they are subject to stress and overfishing.

Tolerance to low dissolved oxygen levels is probably the key criterion for survival of fish in the Souris River. Depressed dissolved oxygen levels generally occur in the winter however concentrations during the rest of the year are often substantially below oxygen saturation as well. For example, of 311 dissolved oxygen measurements taken at the North Dakota/Manitoba border, approximately 15 percent failed to meet North Dakota's standard of 5 mg/L (International Garrison Diversion Study Board 1976). Seventy-seven percent of the failures occurred during ice cover. In winter, concentrations of fish in pools or behind dams are subject to winterkill as low water levels preclude the formation of an adequate store of dissolved oxygen to allow them to overwinter. The International Garrison Diversion Study Board noted that periods of low dissolved oxygen occur regularly on portions of the Souris River and are correlated with flows falling below 0.566 m^3/s. The Board also noted that over the period 1960-1975, the median dissolved oxygen concentration under ice cover at Coulter was 1.8 mg/L and was less than 0.2 mg/L for 25 percent of the measurements taken.

The average annual flow rates for the Souris River at Melita and Wawanesa were 5.43 m^3/s and 7.52 m^3/s respectively for the period 1912 to 1967. Based on Tennant's (1975) "Montana method", 10 percent of flow or in this case 0.54 m^3/s is approximately the minimum instantaneous flow recommended to sustain short-term survival habitat for most aquatic life-forms. Under this regime, channel width, depth, and velocities are all significantly reduced and the aquatic habitat degraded. Many wetted areas are so shallow they would no longer serve as cover, and fish generally would be crowded into the deepest pools. Large fish might have difficulty migrating upstream over riffle areas. Water temperature might become a limiting factor, especially in the lower reaches of the stream in July and August. Natural beauty and stream aesthetics are badly degraded.

The Souris River recreational fishery is popular with local residents who have relatively little opportunity for recreational fishing in southwestern Manitoba. A 1976 creel census of the Souris River recreational fishery in Manitoba estimated angling pressure at 16 900 angler hours. Walleye, pike, and perch were the main species caught. These census data, together with a consumer surplus estimate from a 1987-88 creel census on Oak Lake, provide an estimate of the annual value of the Souris River fishery at around $70,000 (W. Howard, pers. comm.). This is probably a conservative estimate.

If winterkill was not such a frequent event on the Souris, stocks of valuable sport species, such as walleye and northern pike, would probably improve substantially and angler pressure would be expected to increase in concert. While the angling potential is low under existing conditions, the Souris River has good potential for maintaining a viable recreational fishery if flow augmentation occurs during low-flow periods.

Carp have been on the verge of establishing themselves in the Souris River above the Wawanesa Dam for many years. From the information available it appears that this has been prevented by the absence of the right combination of flows, temperatures, and dissolved oxygen at critical times. Under most conditions, the Wawanesa Dam is an effective barrier to the upstream movement of all fish.

When flows are confined between the Wawanesa Dam abutments, the high discharge velocities likely prevent all fish movement past this structure. At about 600 m^3/s, the north abutment is overtopped and reduced velocities along the north shoreline allow fish passage at this point (International Souris-Red Rivers Engineering Board 1984). At about 680 m^3/s, the south abutment is overtopped and allows further passage of fish. An increase in the height of the north abutment would likely prevent all fish movement during all floods approaching the magnitude of the 1976 event. Carp could also be accidentally introduced anywhere in the Souris River system. Angler buckets or dam washouts are likely routes. This latter route of entry may be the most probable since upstream migration of carp does not coincide with spring freshet. Carp spawning usually commences in earnest when water temperature reaches a level of at least 17°C (Scott and Crossman 1973).

8.3 Project Impact

8.3.1 Saskatchewan

The construction of a dam transforms the terrestrial and riverine ecosystems in the affected area upstream of the dam into a lake ecosystem. This results in physical, chemical and biological changes in the aquatic environment as the reservoir develops and stabilizes. The specific nature and extent of such changes would depend upon hydrological events within the catchment area and the operation regime of the reservoir.

Major aquatic resource impacts that would occur during the operational phase of the Rafferty and Alameda reservoirs would likely be related to:

- the blockage of fish movements, the inundation of riverine habitat, and the resultant characteristics of the reservoirs; and
- the effects of an altered flow regime downstream of the reservoirs.

8.3.1.1 Fish Movements

Both the Rafferty and Alameda dams would block the seasonal movements of fish between areas downstream and upstream of the proposed dam sites. In the case of the Rafferty Dam, the downstream area to be isolated is limited to the short stretch of the Souris River between the proposed dam site and the Estevan Power House Dam. This dam effectively blocks upstream movements of fish into this section at all but extremely high water conditions.

Although this area contains suitable northern pike spawning habitat, the use of this habitat appears to be minor. A similar situation occurs in the case of yellow perch. Black bullheads, fathead minnow, and brook stickleback, common species in the watershed, also spawn in this area. The extent of fish migrations between this stretch of the Souris and areas upstream of the dam site appears to be minor. All species currently found between the proposed Rafferty Dam site and the Estevan Power House Dam could also be expected to be found between the Rafferty Dam site and the Dead Lake Dam.

Populations of fish utilized by the recreational fishery are low in the Souris River between the Estevan Power House Dam and the Oxbow Weir. Recruitment into this reach from downstream over the Oxbow Weir occurs only at very high water levels. Recruitment from downstream regions of the Souris River probably involves migrants from North Dakota. Fish movements from the Souris River into Moose Mountain Creek would be limited to the 4 km reach between the proposed Alameda Dam site and the confluence.

Movements of fish between the proposed Rafferty Dam site and the Oxbow Weir are already restricted by a series of major and minor blockages. Twelve additional rock weirs are planned for this area as part of the irrigation proposals for the Souris River lowlands. The current fish populations of this reach are thought to be restricted to the ponds created by the major blockages and then reduced in size due to natural mortality or sport fishing harvest.

Given this situation, the creation of small ponds by additional low-level rock weirs could have both positive and negative effects. On the positive side, the ponds created upstream of the weirs, if deeper than 2 m, could provide refuge for fish during low water periods in summer and winter. Consideration for fish passage should be incorporated into the design of such weirs. If the weirs preclude fish movements other than during major flood events, and the ponds do not meet the habitat requirements of northern pike, the fish would be denied access to suitable habitat at appropriate times and populations might not be maintainable.

8.3.1.2 Fish Habitat

Creation of the Rafferty Reservoir would inundate approximately 57 km of riverine habitat on the Souris River, including the Dead Lake Reservoir and several kilometres of the lower reach of Roughbark Creek, when the reservoir is at full supply level. The only important fish habitat that would be lost to Souris River mainstem fish would be that occurring between the proposed Rafferty Dam site and the Dead Lake Dam. Dead Lake would be replaced by the larger Rafferty Reservoir. The river reaches upstream of Midale Dam which are used for northern pike and yellow perch spawning also would be lost during reservoir formation.

All fish species currently present upstream of the proposed Rafferty Dam site can be expected to do well under conditions in the newly created reservoir. Success of these species however, is heavily dependent upon the degree of water level fluctuation and quality of water to be found in the reservoir. For some, such as northern pike, success would depend on the operational regime of the reservoir. If water levels are rising at spawning time and are maintained high during the egg incubation period, northern pike should do well. Although the area upstream of the proposed dam site is fairly heavily fished for northern pike, perch and stocked walleye, fish populations in this reach are currently small.

In Moose Mountain Creek, the reservoir formed by the construction of the Alameda Dam would replace 24 km of riverine habitat. Modelling by Fernet (1988) indicates that for a variety of operating scenarios without consideration for fisheries mitigation or enhancement, the amount of usable habitat available after reservoir formation would be greatly enhanced for northern pike and walleye as compared to the amount that is presently available in the area to be inundated. Furthermore, modelling predicted that the new reservoir would provide suitable habitat for yellow perch and possibly rainbow trout.

Considerable channel excavation, bottom dredging, and straightening are proposed to increase capacity of the channel for a distance of approximately 16 km downstream of the Rafferty Dam. Fish resources in this area are already limited primarily as a result of stream blockages at Estevan and Oxbow and frequent low water conditions. However, any channelization can be expected to exacerbate this condition. The diverse hydraulic conditions created by meandering channels and pools and riffles, and the habitats affected by overhanging banks and shading from near-stream vegetation are required by some species of fish for spawning, rearing and feeding (Beschta and Platts 1986). In Manitoba, extension of the drainage network and channelization has significantly reduced fisheries and other biologically important habitats in the stream channels and downstream lakes (Newbury and Gaboury 1987).

8.3.1.3 Effects of Reservoir Filling and Operation

The filling period for the two reservoirs would depend on the pattern of annual runoff. The period of filling would be an important one for fish populations downstream of the reservoir. Once the reservoirs are filled, it is anticipated that they both would be operated for water storage and that Alameda Dam would be operated for meeting apportionment commitments. In spring, downstream flows would be less than at present while in summer, flows would likely be greater.

In order to predict the potential effect of various downstream flow conditions during reservoir filling and operation, a modelling exercise (Fernet 1988) was conducted to test the effect of the Project on habitat suitability for northern pike and walleye in the Souris River downstream of the Rafferty Dam and in Moose Mountain Creek below the Alameda Dam. This analysis indicates that during filling the quality of northern pike habitat below Rafferty Dam would remain unchanged from present conditions or decline slightly. In Moose Mountain Creek downstream of the proposed Alameda Reservoir, habitat suitability for northern pike is predicted to remain unchanged if reservoir filling occurs during moderate flow years, and increased if reservoir filling occurs during high or low flow years. The analysis also indicates that during reservoir operations, the Rafferty and Alameda dams would not have an adverse impact on downstream fisheries values in Saskatchewan but would improve habitat for both pike and walleye, even without consideration of any fishery mitigation and enhancement. The periodic high free ammonia concentrations in Rafferty Reservoir releases would have implications to fish immediately downstream (Section 6.2).

Effects of the proposed Rafferty-Boundary diversion channel on fish populations both in Boundary Reservoir and the proposed Rafferty Reservoir are unknown. Flows in the order of 60 m^3/s or even much smaller ones could have a significant effect on water quality in either of the recipient reservoirs. Entrainment of fish in the flow entering the channel and entrapment of fish in the channel as flows are cut off are a concern unless mitigated.

8.3.1.4 Water Quality

The hydrologic events that accompany the initial years of operation would have a significant influence on the resulting water quality within the reservoirs. Both reservoirs would be subject to increased macrophyte growth and algal production as a result of increased nutrient levels. The Rafferty Reservoir would be more severely affected, and in general, less satisfactory water quality would be realized under low inflow conditions.

Within the proposed Rafferty Reservoir, large blooms of blue-green algae may occur in mid to late summer. Decomposition of these materials, supplemented by the addition of organic matter from the newly flooded area may lead to severe oxygen depletion with the possibility of summer fish kills, particularly during periods of hot, calm weather.

Winter conditions in the reservoir would depend on water levels at the time of freeze-up. If water levels are low at that time, there is considerable risk that the reservoir would become anoxic in late winter and fish kills would result. Heavy snow cover would exacerbate this problem. Walleye are expected to be more susceptible to winterkill than northern pike or yellow perch.

Low level releases of anoxic waters from the Rafferty Reservoir during late winter may have detrimental effects on fish overwintering in areas of the Souris River immediately downstream of the proposed dam site. This should not be a problem downstream of the Moose Mountain confluence because of the addition of high quality Alameda Reservoir water at that point.

8.3.1.5 Mercury in Fish

Based on work in northern Manitoba (Bodaly and Hecky 1979, Bodaly et al. 1984), it is predicted that the creation of any new reservoir in cool-temperate areas, accompanied by significant flooding of soils and vegetation, is likely to result in increased muscle mercury levels in piscivorous fish. Flooding appears to stimulate the bacterial methylation of naturally occurring mercury found in the flooded soils. The process of mercury methylation occurs over the entire flooded area and proceeds until the organic soils and vegetation are decomposed completely or buried by sediments.

This methyl mercury works its way through the aquatic food chain, reaching its greatest concentration in the muscle of predaceous fish. The response in fish can be quite rapid with noticeable increases occurring within 2-3 years after impoundment (Bodaly et al. 1984). In some boreal and prairie reservoirs, mercury concentrations have remained high for more than a decade. Mercury levels in walleye from Lake of the Prairies on the Assiniboine River in Manitoba averaged 1.01 mg/kg in 1987, 18 years after initial reservoir filling (A. Beck, pers. comm.).

Currently, it is not possible to predict precisely the fish mercury levels that may result from flooding, but a 3 to 6-fold increase after impoundment seems to be indicated. In new impoundments in northern Manitoba, mean mercury concentrations have ranged from 0.6 to 2.3 mg/kg in pike and from 0.8 to 2.9 mg/kg in walleye. In the L2 reservoir on the La Grande River in northern Quebec, mercury levels in pike now average above 2 mg/kg (Boucher et al. 1985).

This phenomemon is not restricted to boreal situations. In a new impoundment in southern Saskatchewan (Cookson Reservoir), walleye showed mean mercury levels of 1.04 mg/kg (Waite et al. 1980). Recent experimental studies using limnocorrals showed that the addition of prairie sod stimulated methyl mercury production to the same extent as did other organic material and resulted in elevated mercury levels in yellow perch (Hecky et al. 1987). The stimulatory effect of flooding, therefore, seems to be a general response and not limited to boreal areas. Similar results are expected to occur within the newly flooded Rafferty and Alameda reservoirs.

Elevated mercury levels may not be restricted to newly created reservoirs but may extend to fish downstream of dams. On the La Grande River in Quebec and in the Little Jackfish River in northwest Ontario, there is good evidence that downstream fish stocks have experienced increased muscle mercury concentrations. The mechanism for this downstream transport is unknown, but at La Grande, downstream increases in fish that normally eat invertebrates are greater than those occurring in northern pike within the reservoir (Boucher et al. 1985).

8.3.2 North Dakota

Except where otherwise indicated, information in this section is based on information provided in the U.S. Army Corps of Engineers EIS (1988).

Assessing and predicting low flow impacts of the Souris River Basin Project on Lake Darling and other Souris River fisheries is principally dependent upon assessment of available information relative to four factors:

- Meteorologic/hydrologic cycles,
- Operation of Canadian amd American facilities, especially during nonflood years,
- Water storage, water sharing, and water use priorities below the Saskatchewan border, and
- Water quality and other factors directly influencing the manageability of fish populations in the system.

The major impact to fish and fish habitat in North Dakota arising from construction and operation of the Souris River Basin projects would be caused primarily by a reduced water supply and secondly by changes in water quality. With Saskatchewan's retention of its share of the annual flow under presently planned operations, water shortages rather than flooding problems would occur in most years throughout the Souris River loop in North Dakota. Flood operations would require drawdown of Lake Darling in late winter and the subsequent flood events would result in extended durations of high, within-channel flow in the Souris River throughout North Dakota.

Impacts would also occur from direct habitat disturbance and from the temporary suspended solids increase usually associated with construction in or near the water. In general, these latter impacts would be of relatively short duration and localized in the area of construction.

8.3.2.1 Hydrology

The proposal by Saskatchewan to develop the capability to retain 50 percent of the Souris River water has significant potential for adverse impact to fish resources in North Dakota.

Most severely affected would be the management of the Upper Souris and J. Clark Salyer NWR, and especially the fishery in Lake Darling. Clearly water shortages would be the most severe adverse effects of the project. Significant flood control impacts can be expected in less than 10 out of 100 years and water shortages are likely in 75 to 90 out of 100 years. It appears that the United States would annually receive in the range of 45 to 100 percent of the volume of water that has been received historically. The long-term average would be about 67 percent of what has been received historically.

The purpose of Lake Darling is to supply water to J. Clark Salyer NWR. Other uses in the past were possible only because Canada has not been able to retain its 50 percent of the water. From 1959 through 1985, North Dakota received an average of 152 475 dam^3 of water annually, recorded at the Saskatchewan-North Dakota boundary. If Saskatchewan would have been able to retain its 50 percent, North Dakota would have only received an annual average of 74 160 dam^3, less than the water requirement of the two NWRs alone. As a result Lake Darling would be the most influenced and critical segment of the system because it would be needed more often to provide an adequate supply of water to the J. Clark Salyer NWR.

Low flow operations represent a threat to the recreational fishery and other aquatic values. Lake Darling would probably reach potentially critical winter levels about 30 percent more often than present. However, modelling indicates the lake would not recover as rapidly as in the past because of the reduced water supply. The necessity of using Lake Darling to supply J. Clark Salyer NWR requirements not met by local inflows would require decisions that may jeopardize the Lake Darling fishery in favour of the mandated waterfowl needs. Lake Darling would be frequently unable to store a 2-year water supply (75 216 dam^3 per year) for J. Clark Salyer NWR, as is current practice. Lower operating levels could significantly reduce or impact access to northern pike spawning areas.

Retention of treaty-allocated water by Canada and natural sedimentation would increase the frequency the lake winters over, at or below a critical elevation, to about seven years in ten. Winterkill frequency may increase to about one year in five. More frequent winterkills and reduced natural recruitment of fish in Lake Darling would require more intensive stocking in order to maintain the present fishery. However, when June levels are below 485.24 m, restocking would not be attempted.

Models indicate that the combination of low lake levels in winter and insufficient recovery would preclude the maintenance and re-establishment of a viable fishery for periods of many consecutive years. Only during infrequent extended wet cycles could a fishery anything like the one that presently exists be maintained. Chronic low lake levels with their attendant problems would probably result in a decision to abandon fishery management or greatly decrease it. The net effect, in the absence of any offsetting measures, would be a long term decline and possible elimination of the fishery values of Lake Darling.

To a large extent, the conditions necessary for maintaining a viable recreational fishery would be dependent upon moderate to above average (wet) hydrologic cycles. In summary, a "best guess" scenario for the Lake Darling fishery predicts that during dry to moderate hydrologic periods a viable fishery could not be maintained for very long. Only during wet cycles with very limited occurrences of moderate or dry years could a recreational fishery be sustained. In order to maintain the recreational fishery at Lake Darling this "best guess" analysis indicates that even during moderate hydrologic periods late summer/early fall lake levels would very frequently fall below 485.24 m. If successful fisheries are establised at the proposed Rafferty and/or Alameda reservoirs and downstream habitat is maintained to allow fish passage, some recruitment of fish to Lake Darling may accrue on good water years.

Average angler visits would decline as the sport fishery in Lake Darling declines. If, as suspected the fishery at Lake Darling cannot be sustained, this important recreational activity would be virtually eliminated.

The future conditions for the Souris River fishery are not optimistic. Two factors enter into play here, the retention of the Souris River water by Saskatchewan and the viability of the Lake Darling fishery. The aquatic resources of the Souris River are now primarily limited by low flow conditions, which occur nearly every year during late summer, fall and winter. As a result of the Saskatchewan developments, it is expected that there could be an increase in the occurrence of low flows in the Souris River below Lake Darling.

The viability of the Lake Darling fishery may be even more significant to sustaining the Souris River fishery than low flow problems . Lake Darling is considered a major source of fish for repopulating the Souris River following low flow periods, whether they be summer or winter. If the Lake Darling fishery declines as expected if the Project proceeds, a major source of fish for natural restocking of the river would be lost.

The effect of reduced flows would be most significant within the reach downstream of Minot which is already periodically degraded by discharges from the sewage treatment lagoons. Reduced flows would reduce the capacity of the river to assimilate the dilute the residual waste load. The result would be a marginal increase in both the magnitude and the length of the typical dissolved oxygen "sag" below Minot.

A river fishery could be maintained on incidental flows resulting from the passage of water from Lake Darling to the J. Clark Salyer pools. However, during dry years this may not be possible.

8.3.2.2 Flood Operations

The operating plan involves the coordination of releases from flood storage in Rafferty Dam, Alameda Dam, and storage in Boundary Dam in Saskatchewan with releases from Lake Darling Dam in North Dakota to achieve one percent (1:100 year) flood protection at Minot. This drawdown in response to a given predicted flow event is an integral part of the operating plan and is important because the extent of pool drawdown has a direct relationship to the amount of storage available for flood control. The extent of drawdown would depend on the estimated spring runoff volume for each. Estimates of spring runoff would be made initially on February 1 and thereafter on the 15th and last day of each month until runoff occurs. As the estimated spring runoff volume is updated during the spring, the Lake Darling target level would also change. If a one percent or greater flood volume is anticipated, it would be necessary to draw Lake Darling down to an elevation of 484.94 m. Elevation 485.24 m in Lake Darling is considered a critical elevation by which to evaluate the effects of increasing the potential for winterkill.

Drawdown of Lake Darling would increase the potential for winterkill in the lake in the particular year the drawdown occurs. Because of the many factors affecting whether or not Lake Darling winterkills, it is not possible to predict if pre-flood drawdown would actually cause a winterkill or what its severity may be. If pre-flood drawdown did induce a winterkill, the effects upon the fishery of the lake could last for a number of years, depending upon the severity of the winterkill, whether restocking took place, what other natural phenomena occurred in the ensuing years, etc. The effects would also be felt downstream in the Souris River, as Lake Darling serves an important, though unquantified, role in maintenance of the river fishery.

Pre-flood drawdown of Lake Darling would result in the early curtailment of ice fishing due to unsafe ice. This would occur during late February and March. The U.S. FWS has estimated current ice fishing use on Lake Darling in February and March at 15 350 and 10 250 activity-hours, respectively. Some of this recreational use would be lost whenever drawdown is required, an estimated five times in 100 years.

No significant adverse impacts to the fishery of the riverine portion of the Souris River in North Dakota are foreseen from early spring releases. In fact, an early breakup may prove somewhat beneficial in alleviating low dissolved oxygen conditions caused by winter low flows. However the possible flushing of de-oxgygenated water from J. Clark Salyer NWR by upstream releases from Lake Darling would severely impact Manitoba.

A delay in filling Lake Darling would occur following late winter drawdown until mid to late April for the larger floods. Also, peak elevations of Lake Darling can be expected to be about 0.30 to 0.91 m lower during floods than at present. This delay could affect the year-class strength of northern pike, walleye, and yellow perch, all early spawners and the primary fish of interest that successfully spawn in the lake. Northern pike and yellow perch use submerged or flooded vegetation as spawning sites, while walleye prefer gravel/small rubble substrate. Water temperature triggers fish spawning, and if water temperatures rise before preferred spawning sites are flooded, the reproductive success for that particular year will usually be low as the fish attempt to spawn in less than ideal conditions or do not spawn at all. Where the filling of the lake is delayed later than early May, impacts on fish spawning are most likely to occur.

The potential effect of reduced spawning success could have some long-term effects on the success of Lake Darling to support a viable fishery. Each time delayed filling of the lake results in poor spawning conditions, it adds to the difficulty of maintaining a viable fishery.

During events larger than the 1:50 year flood, it would be necessary to prolong the duration of the 14.14 m^3/s released so that all the stored floodwater is eventually released. For floods in the range of the 1:75 to 1:100 year events, the 141.36 m^3/s releases would be extended beyond May 15, with a cutback to 14.14 m^3/s by June 1. The discharge of 14.14 m^3/s would last until late October for the 1:50 year event and until February of the following year for the 1:100 year event.

Summer releases associated with large events would be expected to have both positive and negative effects on the aquatic ecosystem in the Souris River. the erosive effects of peak flood flows would be reduced; however, higher than normal flows associated with the extended releases would exert a higher than normal erosive force on the river channel. This would result in disruptions to aquatic habitat as the river eroded and accreted in various areas to restabilize itself. In certian situations, the river could become more turbid and carry a higher sediment load. On the other hand, the higher flows during late summer could improve fish habitat quality which is currently limited during these periods by low flows. It is important to remember, however, that extended 14.14 m^3/s flows would only occur approximately once every 30 years.

8.3.2.3 Water Quality

Lake Darling is nutrient rich and currently experiences intense algal blooms during the summer. These blooms are composed almost entirely of the blue-green Apahnizomenon flos-aquae. Die-offs of algal blooms exert high demand on dissolved oxygen and can cause the deeper areas of the lake to become anoxic. As discussed previously, low dissolved oxygen conditions have been a problem in the past in Lake Darling, especially during winter, and any deterioration of water quality as a result of the Souris River Basin Project may exacerbate these conditions (see Section 5).

The combined effect of construction activities, trophic upsurge, lower flows, hypolimnetic releases and increased irrigation return flows would probably mean higher nutrient concentrations in Lake Darling and the J. Clark Salyer NWR pools with the inherent risk of increased frequency of winterkill.

8.3.2.4 Carp Introduction

The potential for project-induced migration of carp (Cyprinus carpio) into the U.S. portion of the Souris River has been a significant issue for both the Burlington Dam and the Lake Darling projects in North Dakota. It is believed that carp are presently confined to that portion of the Souris River downstream of the Wawanesa Dam in Manitoba. The concern is that if carp were to migrate upstream of Wawanesa, they could establish themselves in the pools of the J. Clark Salyer NWR where considerable waterfowl habitat is available. Carp thrive in waters rendered unsuitable by accelerating eutrophication for the more traditionally desirable fish species, such as yellow perch and smallmouth bass (Scott and Crossman 1973). Carp are considered detrimental to native fish populations because they increase the turbidity of the water and uproot and destroy submerged vegetation that is essential for the survival of native species. Aquatic vegetation provides cover, food, and sometimes spawning sites for native fish. They also adversely affect waterfowl populations by the destruction of rooted aquatic plants in marshes.

The presence of the right combination of flows, temperatures and dissolved oxygen at critical times could result in the successful invasion of carp into the Souris River above the Wawanesa Dam and below Lake Darling (International Souris-Red Rivers Engineering Board 1980). This combination could result from a number of activities, including improved sewage treatment in urban centers discharging into the Souris River, changes in management techniques in the Souris River NWRs, and diversions for water supply such as proposed in Canada and the United States.

Should carp pass the Wawanesa Dam during a major flood, the extended fall/-early winter 14.14 m^3/s flows during flood operations would increase the chance of the carp surviving over winter in the reach of river below J. Clark Salyer NWR. The national wildlife refuges would provide excellent habitat for carp spawning and feeding but would be prone to winterkills in seven out of 13 years in J. Clark Salyer NWR. The Souris River project includes an electrical carp barrier at dam 357 in J. Clark Salyer NWR. Dam 357 is being raised to above the 100-year flood level. The carp barrier is being designed to function at that level.

8.3.3 Manitoba

This section is based on information provided by U.S. Army Corps of Engineers (1988), Manitoba Natural Resources (1988) and the International Souris-Red Rivers Engineering Board (1984).

8.3.3.1 Hydrology

Construction and operation of the Rafferty and Alameda dams would significantly decrease the water supply entering the United States. Under conditions of the water sharing agreement between Saskatchewan and North Dakota, the U.S. Fish and Wildlife Service would assess its storage capability and need prior to Saskatchewan releasing water to determine if a release is of benefit. If North Dakota would not benefit from the release, the water may be retained for use in Saskatchewan.

In any event the obligation under the 1959 Interim Measures to provide a regulated flow of 0.566 m^3/s into Manitoba during the months of June to October inclusive (7483 dam^3), except in periods of severe drought, would not be affected by the reduced water supply into the United States. It is noteworthy, however that the U.S. FWS is not obligated to deliver 0.566 m^3/s to Manitoba under severe drought conditions, i.e., when the aggregate storage in the refuge pools fall to 66 600 dam^3.

Records indicate the 0.566 m^3/s minimum flow requirement to Manitoba from June 1 through October 31 has been supplied primarily from water in the system below Lake Darling, often from J. Clark Salyer NWR pools. Good water conditions through most of the 1940s and 1950s allowed summer releases from Lake Darling, which assisted in meeting the requirements. Since 1960, special releases from Lake Darling to meet this obligation or to replace water in Salyer pools have occurred in ten years. In the past, the U.S. FWS has released water from Lake Darling to augment low to no flow in the Souris River.

With the Rafferty and Alameda dams retaining Saskatchewan's share of the water, the U.S. FWS would most likely not be in a position to release any water other than what is needed for J. Clark Salyer NWR. This could be as much as 63 percent of the time or greater. This means that six out of every ten years, the Souris River between the two refuges would have no flow during periods outside of spring runoff except for local contributions.

Annual planning for Pool 357 in J. Clark Salyer NWR typically assumed a gradual decrease in storage through the summer to meet the requirement, and other pools were often lowered as well. In years of anticipated shortages, Pool 357 has been filled above the normal target level to store an additional 5551 dam^3 for release to Manitoba. Flows have occasionally fallen below the required maximum due to physical problems with the gates, plugging of low flow structures or problems with the gauging stations. It seems likely that, as a direct result of Souris River Basin Project, North Dakota would declare drought conditions more often than in the past.

Changes in flow regime and magnitude would result in changes to the stream dynamics and eventually reduce the amount of usable fish habitat. Periodic large flows, or flushing, in rivers are beneficial to fish habitat.

Changes in flows would result in downstream changes in the stream channel. Flows for channel maintenance are needed when vegetative encroachment begins to affect flow transport capacity and channel shape, thus predisposing the reach to further encroachment and sedimentation.

The Souris River in Manitoba is already characterized by low flow conditions for much of the year. As a result of the Souris River Basin Project this condition would be exacerbated. More frequent summerkills and a reduced standing crop of fish could be expected as a result. As well it is expected that Lake Darling would be less suitable as fish habitat with the Project in place. Consequently, fish populations in the Souris River below Lake Darling, including those in Manitoba, would be diminished in the long term.

8.3.3.2 Flood Operations

The drawdown of Rafferty, Boundary and Alameda reservoirs and Lake Darling in response to a given predicted flow event is an integral part of the operating plan. The extent of drawdown would depend on the estimated spring runoff volume for each. This later winter surge could serve to flush the J. Clark Salyer NWR pools of de-oxygenated water which then would enter Manitoba, inducing a winterkill. Late winter drawdowns required because of impending flood conditions could be expected to result in fish kills. It should be further added that circumstances which necessitate winter drawdowns are the same conditions which exacerbate winterkill conditions. Winterkills typically occur during winters of excessive snowfalls. Heavy snow covers prevent sunlight from penetrating and creating photosynthesis and oxygen generation under the ice. Winter spilling will also result in the high opacity of ice, which would further aggravate winterkill conditions.

The Souris River in Manitoba is very prone to flooding. The reach north of the international boundary starts flooding at a flow of 4.24 m^3/s. Further downstream flooding starts between 28.27 and 42.41 m^3/s. During flood years the project operation would reduce peak flow in Manitoba, but flood waters would recede much more slowly. Flooded areas are utilized by northern pike and yellow perch for spawning purposes, and such altered flood regimes could reduce recruitment since many potential spawning areas would not become flooded.

Simulations indicate that the flow pattern over the year will also be changed by the Project. With the large storage capacity created by the dams, the frequency of occurrence of flood flows in Manitoba would be reduced. As these stored flows are then released over the summer, normal summer flows in Manitoba would be increased. Average summer flows would be lower in April to June and higher over the rest of the summer.

Manitoba would receive lower average annual volumes of water with the Project in place than it would have historically received. The flow pattern would also be altered. There would be less flow in certain months

(April to June in certain years, for example) and more flow than historically recorded in others (July to September in some years, for example).

Increased and prolonged flows produced by Rafferty and Alameda reservoirs in some years would have a periodic positive influence on Manitoba fish stock maintenance and production. A negative influence could develop from the prolonged summer flows followed by a quick drop from approximately 14.14 m^3/s to normal low fall or winter flows at Westhope. Normal reduced flows in late summer and fall result in fish movement downstream to deeper holding areas as the water levels decline. High constant flows could result in fish holding their position for a longer period of time and then being suddenly exposed to drastically reduced flows. Many fish could be caught in shallow pools without adequate water depth to allow movement to more favourable areas. Reduced flow allows greater ice development and possible freezing to the bottom. Fish trapped in these shallow pools could, therefore, be winterkilled.

8.3.3.3 Water Quality

Water quality impacts may occur as a result of collective changes following the construction of facilities and altered system management. Parameters or conditions of particular concern are the effect of altered flow (low, mean and high) regimes on algal biomass in the lower Souris, transboundary dissolved oxygen concentrations, dissolved and total phosphorus and nitrogen species including ammonia (Section 6.2.4).

The scientific knowledge of the biological behavior of the Souris River ecosystem under various low flow conditions is inadequate to predict what changes, if any, may occur in biological activity in the Manitoba reach of the river under post-project conditions.

A long-term water quality concern may be present in the lower Souris River within Manitoba. In 1980, low flow conditions in the spring were partially responsible for a filamentous algae (Cladophora sp.) bloom downstream of the town of Souris (Beck 1981). The bloom persisted throughout the summer period and impaired aesthetic value of the stream, interfered with recreational activities and reduced dissolved oxygen oncentrations to critical concentrations for fisheries protection. The study concluded that the nuisance growth of Cladophora sp. was caused by a combination of reduced precipitation, abnormal low flows and significantly greater than normal amounts of sunlight coupled with the normally optimal nutrient concentrations in the Souris River. Once the bloom was established, it persisted through the summer period.

The normal operations of Rafferty and Alameda Reservoirs, coupled with the operations of other control structures in the Souris River watershed, may give rise to frequent nuisance filamentous algae blooms within Manitoba. These frequent nuisance bloom conditions may significantly impair the existing water uses within Manitoba.

8.4 Mitigation

The Department of Fisheries and Oceans' long-term policy objective, as endorsed by Saskatchewan and Manitoba, is the achievement of an overall "net gain" of the productive capacity of fish habitats. Progress toward this objective can be achieved through the active conservation of current productive capacity of habitats (no net loss), the restoration of damaged fish habitats and the development of habitats. The following points are presented as possible means to mitigate fish habitat losses that may result from the Project and to strive for a "net gain" of productive fish habitat as called for in the Fish Habitat Management Policy.

8.4.1 Saskatchewan

Reservoir fisheries can be dramatically improved by manipulating water levels (Ploskey 1986). Management of the reservoir for fisheries may include:

- drawdown of water levels in late summer or fall,
- establishments of terrestrial vegetation by seeding or allowing for recolonization,
- flooding vegetation in spring, and
- maintaining high water for as much of the growing season as possible.

The chances of maintaining viable reservoir fisheries increase by monitoring fish communities annually and identifying community and reservoir characteristics that favour production of strong year classes.

A fisheries management plan would provide direction and a long-term perspective to develop and maintain a fisheries management program for Rafferty and Alameda reservoirs and downstream reaches of the Souris River to the international boundary. The objective of the program would be to develop, enhance, and maintain the fish communities and habitats of Rafferty and Alameda reservoirs and the Souris River to provide a recreational fishery of the highest possible quality.

Artificial structures, mainly fish attractors, have been used for many years to enhance recreational fishing in reservoirs (Brown 1986). Fish attractors can be categorized by the type of material used. The major ones are brush, automobile tires, stake beds, standing timber and shoreline vegetation. Many other materials have been used including gravel beds, log cribs, flue tiles and precast concrete forms but these types have not gained wide acceptance.

An inventory of all bottom types in the reservoirs could be undertaken for consideration of shoal spawning habitat development. All areas where gravel/rock are removed could be terraced at different elevations to create potential spawning habitat, in response to highly fluctuating water levels expected in the reservoirs. Accessibility to these areas by spawners would of course be required.

The development of walleye rearing ponds could be considered. The rearing ponds could be used to supplement the natural reproducing walleye populations, replenish an unpredicted winterkill and develop viable walleye fisheries in southeast Saskatchewan water bodies.

Dams or weirs which hinder or block upstream fish migrations may result in significant losses to the productive capacity of a river system. Fishways reduce such losses by facilitating fish migration over such dams or weirs. Young fish may also be prevented from entering water intakes by providing appropriate screens.

In mobile bed streams, the geometry of the "natural" stream channel in profile and in cross-section is determined by the geology of the basin, the extent of the tributary drainage area, and the position of a stream reach in the hierarchical order of the drainage network. Selected aspects of this "natural" stream geometry can be simulated in rehabilitation schemes that enhance or create physical stream characteristics in the uniform drainage canals that have been significantly altered biologically and hydraulically. In Manitoba, experimental rehabilitation and enhancement works in Wilson Creek and Mink River have re-stablized the channels and created new pool and riffle habitats for fish spawning and rearing (Newbury and Gaboury 1987).

It is now fairly clear that it is the stimulatory effect of decomposing vegetation and soil organic material on bacterial production that is the cause of the reservoir mercury problem. A logical mitigation method is the removal of the sod and upper soil layers, but this would be expensive and has not been tested. An opportunity for experimental management may exist in the Rafferty-Alameda situation i.e., remove the sod and upper soil from one reservoir and not from the other and monitor water and fish mercury levels in both reservoirs. Any monitoring program should be established prior to impoundment and extend for at least five years after impoundment. A well planned program would involve a once per year collection of at least 25 fish of each species covering the size range consumed by humans (northern pike, walleye, yellow perch, any introduced species). The same laboratory should be used for the life of monitoring program.

8.4.2 North Dakota

Available options to salvage the fishery at Lake Darling appear somewhat limited. These, as outlined in the U.S. Army Corps of Engineers EIS (1988), are as follows:

(a) Maintain higher water levels in Lake Darling. This would be possible but at the expense of reducing water levels necessary at J. Clark Salyer NWR for waterfowl production and management.

(b) Obtain additional water from Canada to maintain higher Lake Darling levels. It is unlikely however that Canada would have any additional water to supply.

(c) Install mechanical aerators. This would be an expensive option for a lake the size of Lake Darling. This option would also have to be reviewed for impact on waterfowl, as maintaining open water in the lake over winter with aeration would likely result in waterfowl stayover.

(d) Lake Darling could be diked off to create a smaller impoundment that would more efficiently use reduced water supplies. However, uses of National Wildlife Refuges (NWR) in the United States are governed by the National Wildlife Refuge System Administration Act (Act) (16 U.S.C. 668 et seq.). This Act requires that before any use may occur on an NWR the Service must determine that the proposed use is compatible with the purpose for which that refuge was established. If the use is not or cannot be made compatible, the use cannot be permitted. It would appear that such a fish refuge would not be compatible with the primary purpose of the refuge which is migratory birds.

It is not likely that carp can be controlled on J. Clark Salyer NWR by imposing winterkill conditions. There are enough areas of deep water and springs in and upstream from the refuge to allow overwintering carp survival, even under extreme low-flow or drawdown conditions. Fish survived 1988-1989 with three pools in drawdown, very little water in the other two pools, and virtually no flow in the river.

8.4.3 Manitoba

Since the Souris River Basin Project is expected to exacerbate low flow conditions in the Manitoba portion of the Souris River, the achievement of "no net loss" of fish habitat may require, in part, a change in the operating plan for the Project. For instance, in reference to Saskatchewan, Fernet (1988) states that:

> **"From the perspective of maintaining or enhancing fishery values in the riverine environments, it may well be highly advantageous to store more flow during the spring freshet (and possibly reduce further the undesirable high spring flows, and thus the changes in water elevations between the spawning and early fry life stages). This water could then be released during the summer and fall months to reduce the incidence of low or no flow situations."**

This statement could also apply to areas further downstream in the Souris Basin.

Compensation for the loss or harmful alteration of fish habitat due to lowered annual flows, changes in flow regimes including reduced flood peaks, and altered water quality would be required since it is expected that these impacts could not be avoided with the Project in place. Such compensation might include replacement habitat or artificial production. For example, some overwintering capability in the Souris River in Manitoba could be maintained by installation of mechanical aerators at the low level reservoirs at Wawanesa, Souris, Napinka, Hartney and Melita.

Manitoba fish stock maintenance could be improved (net gain of productive fish habitat) by increased year-round flows. This may be accomplished through the adoption of a higher Lake Darling conservation pool (to reduce the present frequency of winterkill above Lake Darling Dam) and the maintenance of higher winter flows (when Lake Darling storage elevations allow) through J. Clark Salyer NWR and Manitoba. The maintenance of winter flows (when Lake Darling storage elevation allows) above 0.566 m^3/s would improve water quality, reduce the likelihood of fish winterkill and improve overall fish populations in Manitoba and North Dakota. Manitoba fish stock maintenance and production could be improved by increased year-round flows. Overwintering fish stocks, especially of the more sensitive species such as yellow perch and walleye, could be maintained if their presence were coincident with high water occurrence. If additional flows were available, angling success would be expected to improve due to the availability of sport species throughout the winter and an increased population resulting from spawning the following spring.

The use of aeration through spray pipe release and/or a series of baffles and lower head dams below each of the refuges in North Dakota could assist in the improvement of water quality entering Manitoba particularly when it is necessary to dump anoxic waters because of impending flood conditions. The potential to aerate below J. Clark Salyer Refuge dams could be improved through the upgrading of the refuge dams.

In the event that carp invade upstream areas and their numbers reach the point where fish and wildlife resources in Canada and North Dakota would be detrimentally affected, the Manitoba Fisheries Branch would be willing to permit intentional reduction in water elevations and flows to achieve winterkill conditions and eliminate the species from the Souris River in Manitoba (W. Howard, pers. comm.). Such a policy on Manitoba's part would probably require that North Dakota agree to provide larger winter flows to Manitoba in "non-carp" years. Any decision to impose winterkill should be coordinated between U.S. and Canadian agencies. A reduction in water elevations and flows would likely result in the stranding of sport fish. Salvage operations to transfer major fish concentrations might be possible or relaxed regulations would be developed to allow increased harvests and reduce fish waste. Overall, an improved sport fishery could be considered as mitigation for those periods when all sport species must be sacrificed through induced winterkill.

8.5 Residual Impacts

8.5.1 Saskatchewan

Low flows downstream of the proposed dams can be expected to produce residual impacts on fish resources. Losses of riverine and gains of reservoir fish habitat are anticipated if the Project proceeds.

8.5.2 North Dakota

The Saskatchewan Reservoirs would likely have significant impact upon fish and fish habitat in North Dakota. As a result of Saskatchewan's retention of its share of the annual flow and the planned flood operations, there would be a decline and possible elimination of the fishery values of Lake Darling and of the Souris River proper.

8.5.3 Manitoba

During flood operations flood peaks in Manitoba would be lower and of longer duration. This can be expected to negatively impact northern pike and yellow perch spawning success. Lower than historic annual volumes of water and altered water quality would lead to an overall decline in fishery values if lost and degraded fish habitat is not adequately compensated for.

9 FEDERAL LANDS

9.1 Description of Federal Lands

9.1.1 Federal Lands in the Souris River Basin

Federal lands fall into two types: titled and unalienated crown lands. Titled lands include property purchased by federal departments and Dominion Lands.

The total area of federal departmental land holdings in the Canadian portion of the Souris River Basin is 59 937.49 ha. Table 9.1 summarizes the land area owned by each federal department in the basin. Eight federal departments own 99 properties, with the major owner of land being the Department of Agriculture (Environment Canada 1987, 1989).

Table 9.1 Federal Departmental Land Holdings Within the Souris River Basin

	Area (ha)		Total
Federal Department	Manitoba	Saskatchewan	Watershed
Agriculture	.11	59 695.09	59 695.20
National Revenue	2.87	13.92	16.79
Canadian Broadcasting	7.53	27.69	35.22
Canada Post	.50	1.20	1.70
Public Works	.33	1.53	1.86
Health and Welfare	-	.09	.09
RCMP	3.54	3.82	7.36
Environment	16.28	163.00	179.28
Total	31.16	59 906.33	59 937.49

There are three Indian reserves in the watershed with a total area of 16 197 ha. These Reserves are: Whitebear and part of Assiniboine in Saskatchewan and Oak Lake in Manitoba.

Dominion lands are lands acquired by the federal government from the Hudson Bay Company after Confederation. After the Transfer of Natural Resources Agreements of 1930, those lands still held by the federal government were classified as Dominion lands. A full description and explanation of this type of federal land is contained in the Environment Canada (1986) publication 'Dominion, Admiralty and Ordnance Lands in Western Canada: The Status of Ownership'. The Canadian Parks Services' Program Management Branch on behalf of Environment Canada has the responsibility for administration of these lands.

Where lands were retained by the federal government and a Certificate of Title was issued after 1930, the federal government would have retained the sub-surface rights unless the Certificate of Title explicitly excluded the sub-surface rights.

In the Souris River basin, there are two properties that are Dominion Lands. These are the 'Estevan Brick Co.' property and a 'road allowance' property, a total of 16 ha. Both properties are owned by Environment Canada. Sub-surface rights are also retained for the 'Estevan Brick Co.' property.

9.1.2 Federal Lands Directly Impacted by the Project

Of all these federal lands in the Souris River basin, only two would be directly impacted by the Project. These are the Estevan-Cambria Community Pasture and the Lomond #1 Community Pasture. Title for both is vested in Crown Canada under Agriculture Canada, and they are administered by the Prairie Farm Rehabilitation Administration (PFRA).

The impacts of Rafferty Reservoir on the Estevan-Cambria and Lomond #1 Pastures were addressed in the Saskatchewan Environmental Review. In the SBDA EIS, the Project Proponent, stated that it would replace the lost land base through acquisition of an equal amount of suitable adjacent land (SBDA 1987a). In September, 1987, PFRA Community Pasture Committee Chairmen participated in the Public Hearings, conducted by the Rafferty-Alameda Board of Inquiry. As a result of these hearings, the Saskatchewan Minister of the Environment approved this project under the authority of the Saskatchewan Environmental Assessment Act, on the condition, stated in Section 7 of the September 15, 1988 Ministerial Approval, that:

> **"the proponent replace community pasture lands which are rendered inoperable by the development on a carrying unit for carrying unit basis or as is otherwise agreed to by those responsible for the community pastures in question."**

PFRA, on behalf of Agriculture Canada, has therefore concluded that the impacts of this project on federal pasture resources would be fully mitigated. This environmental assessment decision has been registered with the Federal Environmental Assessment and Review Office in Ottawa. Agriculture Canada would, therefore, be able to continue to provide the same level of services to federal community pasture patrons in this area.

The SBDA is in the process of implementing a mitigative plan for replacing federal pasture resources that would be impacted by Rafferty Reservoir to comply with the Saskatchewan licence. Prior to the April 10, 1988 Federal Court decision, PFRA had agreed in principle to the mitigation plan for the transfer of land of the Estevan-Cambria Pasture. The Proponent is currently in the process of assembling land parcels to meet transfer requirements at Lomond #1 Pasture. Land transfer arrangements to mitigate the adverse impacts of Rafferty Reservoir on federal lands administered by Agriculture Canada will not be completed until the results of this IEE are known.

The following assessment, based on a review of the Provincial EIS and other relevant information, is provided to clarify impacts and mitigation measures relative to federal lands.

9.1.2.1 Location

The Estevan-Cambria Community Pasture is located south of the Souris River 5 to 11 km northwest of the proposed Rafferty Dam. It straddles the boundary between the Rural Municipalities of Estevan #5 and Cambria #6. It was established in 1937 and contains 2705 ha of land, approximately 42 quarter sections (Figure 9.1).

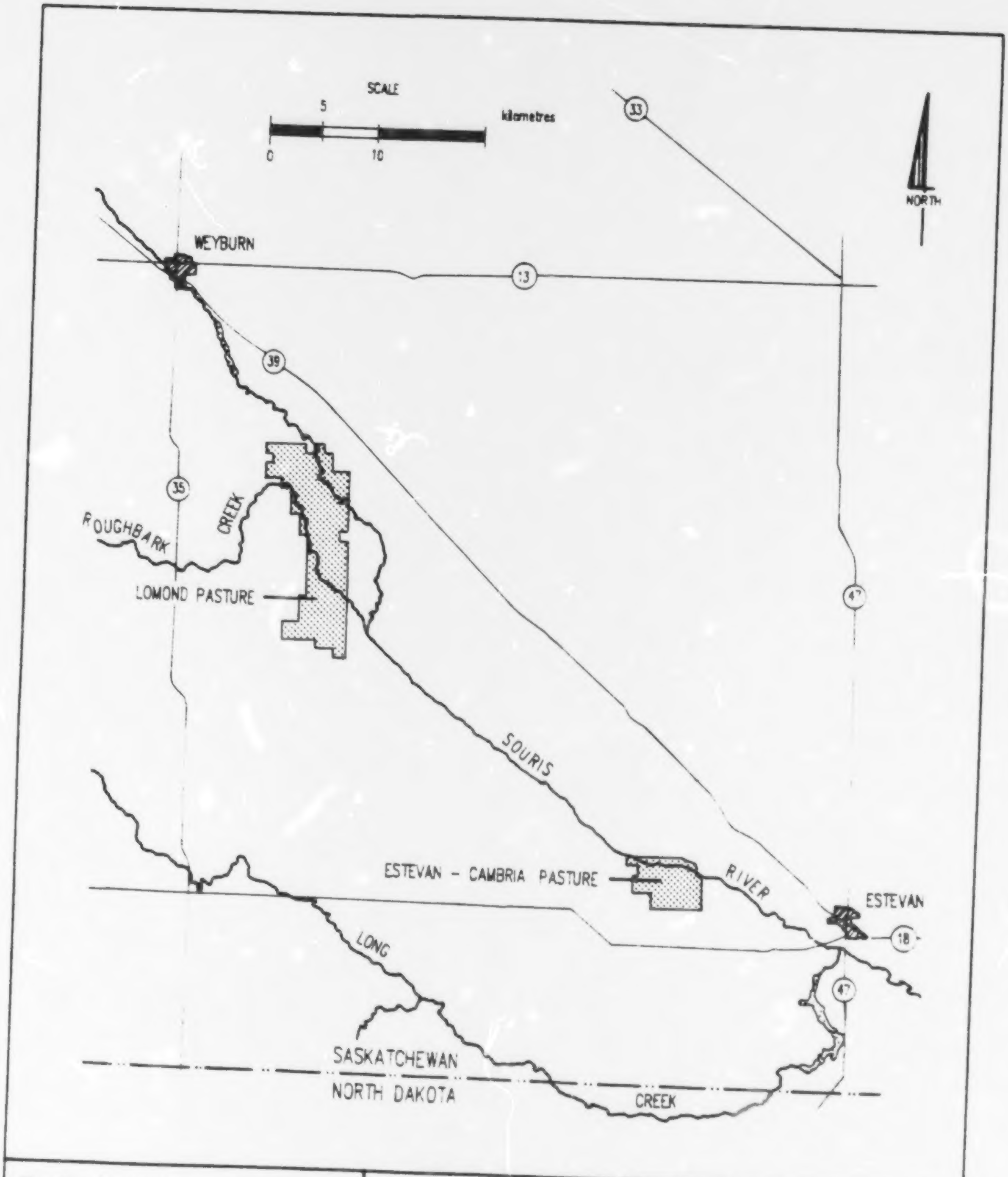
The Lomond #1 Pasture was established in 1938. It is a medium-sized community pasture in the extreme northwest corner of the Rural Municipality of Lomond #37, east and north of Goodwater. The pasture contains 9 502 ha of land in Townships 5 and 6, Range 13, west of the 2nd Meridian. It is made up of 148 quarter sections (Figure 9.1).

9.1.2.2 Land Ownership and Agreements with the Province

The two community pastures were assembled from parcels of land, which had been abandoned or had reverted for taxes or in some cases, were owned by or purchased from private landowners by the province. During the Depression, however, the province was short of funds. Therefore the federal government purchased some land from private owners following transfer of the original parcels. The bulk of the land owned and purchased by the province was transferred to PFRA, now part of Agriculture Canada, in 1937. In 1949 an agreement was signed between the provincial and the federal governments formally transferring all lands and containing a clause stipulating that if the lands ceased to be used as pasture lands they would revert back to the province. Some uncertainty exists as to whether this agreement applies to the lands purchased directly by the federal government as well as the transferred lands. All lands in Estevan-Cambria Pasture are transferred lands while Lomond #1 contains 471 ha of federally purchased lands.

9.1.2.3 Topography

Both pastures are part of the relatively flat Souris plain, which near the valley of the Souris was scoured clean of much of its finer material by glacial meltwaters leaving a stony surface. The Souris Valley cuts across the north-east part of the Estevan-Cambria Pasture. The Lomond #1 Pasture is divided into three parts by the valleys of the Souris and two tributaries. The valley bottoms are usually flat with steep sides and contain a narrow-channelled meandering stream. Spring runoff usually floods the valley.



Environment Canada
Conservation and Protection

Environnement Canada
Conservation et Protection

DATE: July, 1989

Rafferty - Alameda Project Initial Environmental Evaluation

FIGURE: 9.1 PFRA Community Pastures

SOURCE: Sask EIS

9.1.2.4 Soils and Vegetation

Generally, the course of the river valley describes a band of poorer agricultural land. The two pastures are almost entirely within this band. Almost all the soils in the pastures are Canada Land Inventory soil capability Classes 4 and 5. The Class 4 soils have severe limitations for field crops and Class 5 soils are only suited for permanent pasture/hay and wild pasture. The soils on the uplands are also very stony. Generally the surface cover is grass with some shrub cover along the banks of the streams.

9.1.2.5 Land Use

Cattle grazing is the primary use of the land. It serves as pasture land for patrons who bring their cows to it. In 1986 the Estevan-Cambria Pasture served 16 patrons with a total of 445 cows. In the same year the Lomond #1 Pasture served 37 patrons with a total of 1020 cows.

9.1.2.6 Carrying Capacity

The productivity and usefulness of a pasture is usually described by its carrying capacity and grazing rate. Carrying capacity is measured by the number of acres required to support one animal for a month or Acres/Animal Unit/Month (AUM). The usual grazing season in the area is five months. A more detailed explanation is contained on page 17, chapter 12 of the SBDA's Environmental Impact Statement.

The carrying capacity for the Estevan-Cambria Pasture is estimated at 12.5 acres/animal unit/5 month season or 2.5 acres/AUM. This could be substantially lower during periods of drought. This translates into a stocking rate of 525 cows for the pasture. The actual current stocking rate, however, is 445 cows, a 15 percent reduction due to the present extended drought.

The carrying capacity of the Lomond #1 Pasture is estimated at 11.7 acres/animal unit/5 month season or 3.34 acres/AUM. This translates in 1986 to 2000 cows for the pasture. However, due to the extended drought, the actual current stocking rate is 1020 cows or a reduction of 49 percent.

9.1.2.7 Improvements

The major improvements in both pastures are boundary fences, cross fences, dugouts and corrals. In the extreme northwest corner of the Lomond #1 Pasture is a stock-watering and irrigation reservoir.

9.1.2.8 Economic Value

Information on the value of the land and improvements is not readily available. Information was also not available as to the economic importance of these pastures to the patrons and consequent effects on the viability of their farms.

9.2 Project Impacts

9.2.1 Estevan-Cambria Community Pasture

9.2.1.1 Loss of Land

The major impact on the Estevan-Cambria Pasture would be the direct loss of land to the reservoir area. A large island would be created northwest of McDonald Lake and would be inaccessible to pasture use. In addition, considerable amounts of pasture land would be flood-prone at elevations up to 554 m. Although not directly flooded at the full supply level of 550.5 m, much of the land would become a long peninsula between fingers of bays extending westward from the main reservoir channel. These areas would be difficult and costly to fence and manage as pasture. A total of 850 ha would likely be lost to the community pasture. This is approximately 32 percent of the total area of the pasture.

9.2.1.2 Loss of Access

With the pasture headquarters located at the western side of the pasture, the main access route to the pasture is the Macoun-Outram road and the bridge crossing approximately 13 km south of Macoun. This road and crossing has been especially important to those patrons living southwest of Macoun who herd their cattle to the pasture. With the creation of the Rafferty Reservoir, the Macoun-Outram crossing would be eliminated.

9.2.1.3 Impact of Loss on Carrying Capacity and Access

As a result of the loss of grazing land, the carrying capacity of the pasture would be reduced by nearly 170 cows or a reduction of 32 percent. This loss of carrying capacity would lead to reduced grazing privileges with each patron facing a reduction of ten to eleven cows if losses were divided equally.

A number of patrons north of the Reservoir would be unable to herd their cattle to pasture due to the lack of direct access and could choose to forego their grazing privileges or they could assume the additional costs of trucking their cattle to the pasture.

9.2.1.4 Economic Impact

The reduction of grazing privileges and/or the lack of direct access could reduce the economic viability of patrons dependent on the community pasture for grazing land. For these and some other patrons, the raising of cattle could become uneconomical. For others, the costs could be raised due to the need to truck their cows to other community pastures. Data on the economic impact on patrons were not available.

9.2.2 Lomond #1 Community Pasture

9.2.2.1 Loss of Land

Rafferty Reservoir, at the Initial Operating Level of 549.5 m would not inundate the Souris Valley flood plain within the pasture. The upper extent of the reservoir would only reach the eastern boundary of the pasture. The reservoir does, however, extend approximately 7.5 km into the pasture up the Roughbark Creek Valley and approximately 2 km up the Jewel Creek Valley at the full supply level (FSL). Cattle would be fenced away from the reservoir boundary and from shoreline at normal operating levels. An estimated 840 ha would be fenced out of the pasture. This represents 8.8 percent of the total pasture land base.

Approximately 500 ha would require flood easements within the pasture to accommodate potential floods above the FSL up to 554 m elevation. However, this would not be lost land and would continue to be used as pasture.

9.2.2.2 Loss of Access

The present Primary Grid #705, the main access road to the pasture headquarters, would be flooded. (See 9.3 Mitigation).

The flooding and fencing of the Roughbark Creek and the Jewel Creek valleys would split the pasture up into three sections. This would essentially divide the pasture into three areas with different carrying capacities and problems of access from the pasture headquarters.

9.2.2.3 Impact of Land Loss on Carrying Capacity

As a result of the loss of grazing land the carrying capacity of the pasture would be reduced by about 177 cattle, a reduction of nearly nine percent. The number of cattle affected is approximately the same as with the Estevan-Cambria Pasture. However, as this is a much smaller reduction of the overall carrying capacity of the pasture, its effect would be much less than it would be in the Estevan-Cambria Pasture case. This loss of carrying capacity would lead to reduced grazing privileges with each patron facing a reduction of four to five cows if losses were divided equally.

9.2.2.4 Impact of Loss of Access Within the Pasture

The splitting up of the pasture into three sections would require the design of essentially three different pasture management plans and the allotment of the patrons' cows to these different pastures. Access for pasture staff to reach those parts of the pasture cut off from the pasture headquarters would also have to be provided.

9.2.2.5 Economic Impact

The reduction of grazing privileges could affect the economic viability of patrons' farms, particularly those with small herds who dependent on the community pasture for grazing land and whose primary income is from raising animals. However, the economic impact is expected to be less than with the Estevan-Cambria pasture. Economic data on the impact were not provided by the provincial EIS.

9.2.3 Impact on Downstream Federal Properties

The Souris River in Manitoba is very prone to flooding. The report "The Rafferty/Alameda Dams Project: Implications for Manitoba" October 1988, by the Manitoba Natural Resources, indicates that in terms of agricultural and urban flooding, there would be an annual net benefit from the project. This would be mainly due to a reduction of flood flows from western North Dakota and Saskatchewan.

Therefore, it is expected that by lowering the flood risk to communities normally having a high flood risk, the Project would also have a positive impact on federal properties located in these communities. There are eight federal properties in the communities of Melita, Hartney, Wawanesa and Souris that could potentially benefit from the project. The Manitoba report provides estimates of the flood damage reductions for urban areas but it is beyond the scope of this report to estimate what these benefits would be to specific federal properties.

9.3 Mitigation

The Project would have a major impact, if there is no mitigation, on two federal lands. These are the PFRA-administered pastures of Estevan-Cambria and Lomond #1. The impact would be in the form of loss of pasture land and loss of access resulting in a low carrying capacity and therefore having a negative economic effect on the patrons using these pastures.

A condition is contained in the February 15, 1988 Ministerial Approval of the project requiring that these impacts be mitigated. The SBDA has developed a mitigation plan for the pastures. The PFRA has approved, in principle, the mitigation plan for the Estevan-Cambria Pasture and the proponent is actively assembling replacement lands for lands which would be lost in

Lomond #1 Pasture. Therefore, the PFRA, on behalf of Agriculture Canada, has concluded that the impacts of the project on the federal pasture resources it administers would be fully mitigated.

The land transfer arrangements to mitigate the impact will not be completed until all approvals required for this Project are in place.

9.3.1 Estevan-Cambria Community Pasture

The Estevan-Cambria Community Pasture would be the first of the PFRA community pastures to be affected by the initial filling of the reservoir, therefore, it is the first for which mitigation measures should be taken.

8.3.1.1 Mitigation for Loss of Land

In accordance with the Ministerial Approval under the Saskatchewan Environmental Assessment Act, the Souris River Basin Development Authority has initiated negotiations with private land owners for options to purchase land to replace the land lost. An estimated 12 quarter sections of equivalent land would be required to mitigate the loss. PFRA is being consulted on this land acquisition.

The Ministerial Approval requires the replacement of pasture lands on a carrying unit for carrying unit basis or as is otherwise agreed to by PFRA. PFRA has, therefore, attached specific conditions as to the acceptability of the replacement land. To date these conditions are:

a) the land must be adjacent and contiguous with similar fields (native or tame forage) in an existing pasture; and
b) where the native pasture is replaced by cultivated land, the land acquired must be converted to a tame forage stand satisfactory to PFRA and, in total, be equivalent in carrying capacity to the land lost.

9.3.1.2 Mitigation of Loss of Access

A public access road would be built across the Rafferty Dam, with connecting roads north to Highway 39 and south to Highway 18, to permit truck access to the pasture. The corrals at the pasture would be relocated to facilitate the new access, but some minor increased cattle transportation costs would occur for four or five pasture patrons southwest of Macoun as they would be no longer able to trail their cattle to pasture.

9.3.1.3 Other Mitigation Measures

The SBDA would also fence the new boundaries of the pasture, put up new cross-fencing, construct new dugouts and relocate corrals as required.

9.3.1.4 Impact of Mitigation

If the acquisition of land by SBDA is by negotiated sale there would be no economic impact, however, if the land is expropriated then there would be an impact. There is no indication in the EIS as to what this could be in terms of economics or land use. There is also no indication what mitigation alternatives the Authority would use if they are unable to acquire sufficient land. These impacts apply to all lands obtained under various mitigation measures for a variety of primary impacts.

9.3.2 Lomond #1 Community Pasture

9.3.2.1 Mitigation for Loss of Land

It would be some time before the Reservoir will reach the full supply level at 550.5 m, and therefore, the 840 ha could continue to be utilized for pasture use for some time. However, the SBDA indicates that it recognizes the importance of this pasture to the local patrons and would attempt to acquire alternative lands as soon as possible to reduce the net impact on the pasture. The estimated amount of land required is equivalent to 6 quarter sections. PFRA would apply the same conditions for acceptance of this land as replacement.

9.3.2.2 Mitigation for Loss of Access

The SBDA proposes that the Primary Grid #705, the major access road to the pasture headquarters, be raised so there would be no negative impact from an accessibility point of view.

The accessibility problem created by the breakup of the existing pasture into three sections by the flooding and fencing of the reservoir area could be solved by the proper location of the land to be acquired as replacement for the land lost. This would allow for the continuing operation of the pasture as a unit. Alternatively, the pasture could be operated as three units with the loss of grazing efficiency made up by additional lands.

9.3.2.3 Other Mitigation Measures

Other mitigation measures to be carried out would be the construction of fencing, construction of dugouts and corrals.

9.3.2.4 Impact of the Mitigation Measures

These would be the same as those indicated under the Estevan-Cambria Pasture section.

10 RARE AND ENDANGERED SPECIES

10.1 Introduction

The federal government, although having no direct legislative mandate for the management of rare and endangered wildlife, participates cooperatively with the provinces and on an international level towards their conservation and protection. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC), established in 1977, is a national committee and includes representatives from federal and provincial government and non-government agencies. The federal government, through the Canadian Wildlife Service (CWS), provides a secretariat to COSEWIC in support of the Committee's work. The Committee establishes nationally the official status for wildlife species considered in jeopardy in Canada and provides relevant literature on classified species. The COSEWIC list of endangered wildlife includes species of plants, birds, fish, mammals, reptiles and amphibians, but not invertebrates.

In the United States, species are protected by the Endangered Species Act of 1973. Categories established by COSEWIC are similar, but not identical, to those in use in the United States.

10.2 Definitions of Status

The following five status levels are assigned by the committee: rare, threatened, endangered, extirpated and extinct.

The Committee considers information from any knowledgeable source and, if evidence is clear, assigns status in one of the following categories:

> **Rare Species:** Any indigenous species of fauna or flora that, because of its biological characteristics, or because it occurs at the fringe of its range, or for some other reasons, exists in low numbers or in very restricted areas in Canada but is not a threatened species.
> **Threatened Species:** Any indigenous species of fauna or flora that is likely to become endangered in Canada if the factors affecting its vulnerability do not become reversed.
> **Endangered Species:** Any indigenous species of fauna or flora whose existence in Canada is threatened with immediate extinction through all or a significant portion of its range, owing to the action of man.
> **Extirpated Species:** Any indigenous species of fauna or flora no longer existing in the wild in Canada but existing elsewhere.
> **Extinct Species:** Any species of fauna or flora formerly indigenous to Canada no longer existing elsewhere.

For the purpose of the preceding discussion, species means any species, subspecies, or geographically separate population.

10.3 Rare, Endangered, and Threatened Bird and Mammal Species

About 11 species on the COSEWIC list have some potential to be affected by construction and operation of the Project in Canada and the United States, since they have been shown to frequent the study area (Table 10.1). The bald eagle identified in the U.S. Army Corps of Engineers EIS as an endangered species in the United States is sufficiently common in Canada not to require designation on the COSEWIC list.

Presentations offered by the public at the public meetings and supplementary information received from interested agencies occasionally touched on rare and endangered fauna other than the eleven species dealt with in the IEE. Some, such as the swift fox, are presently the focus of national recovery programs. It was felt that these other species would not be influenced to any extent by project construction or operation and are therefore not considered in the final IEE.

Species that are rare within the study area and at the limit of their range may not necessarily be endangered in regards to their overall numbers in Canada. Such species, though considered rare in one or both of the prairie provinces under consideration, are also not included in this assessment unless they appear on the current COSEWIC (1988) list.

A case in point are two fish species, the bigmouth shiner (Notropis dorsalis) and silver chub (Hybopsis storeriana). Both species of minnow were noted by Manitoba as being rare in the province and possibly occurring in the Souris River. Neither, however, appears on the COSEWIC list.

10.3.1 Distribution and Existing Habitat, Saskatchewan and Manitoba

10.3.1.1 Peregrine Falcon

Both sub-species of peregrine falcon are noted in the SBDA EIS as seasonal migrants throughout southeastern Saskatchewan. Some spring and fall staging near lakes and reservoirs in the basin probably takes place.

10.3.1.2 Loggerhead Shrike

This species is a rare but possible breeder in the Souris River valley. A single loggerhead shrike was observed in the valley during a three week intensive bird survey (Adam 1988). This observation occurred upstream of the proposed Rafferty Reservoir. Several other observations during the survey were made in the uplands well away from the valley (Adam 1988). There was only one loggerhead shrike sighting among 1875 observations of birds preferring grassland or shrub habitat (Adam 1988) in the valley, suggesting that the area does not have suitable breeding habitat for this species.

Table 10.1 **Birds and Mammals**

Species	Scientific Name	Current Status
Birds		
Baird's Sparrow	Ammondramus bairdii	Threatened
Burrowing Owl	Athene cunicularia	Threatened
Cooper's Hawk	Accipiter cooperii	Rare
Eastern Bluebird	Sialia sialis	Rare
Ferruginous Hawk	Buteo regalis	Threatened
Great Gray Owl	Strix nebulosa	Rare
Loggerhead Shrike	Lanius ludovicianus	Threatened
Peregrine Falcon	Falco peregrinus tundrius	Threatened
	Falco peregrinus anatum	Endangered
Piping Plover	Charadrius melodus	Endangered
Whooping Crane	Grus americana	Endangered
Mammals		
Prairie Long-Tailed Weasel	Mustela frenata longicauda	Threatened

The province of Manitoba confirmed the paucity of this species in the Souris River Basin although correspondence received from the public suggests otherwise for the Saskatchewan portion of the valley. Sightings by the public, however, are unofficial and unconfirmed.

10.3.1.3 Cooper's Hawk and Great Grey Owl

The Cooper's hawk is a rare summer resident in wooded areas of southern Saskatchewan. Its presence has been identified at three locations along the Souris valley (Adam 1988). Of particular interest is the sighting near Dr. Mainprize Park in the vicinity of the proposed location for the Rafferty Reservoir (Adam 1988).

A sole great grey owl observation was recorded in the study area and reported in the SBDA EIS (1987a). The rarity of this species in Manitoba portion of the Souris River valley was confirmed by the province.

10.3.1.4 Whooping Crane

Whooping cranes migrate between the salt marshes of Aransas Wildlife Refuge, Texas and their nesting grounds in Wood Buffalo National Park, Northwest Territories. They tend to use large marshes, slow streams and agricultural land in the central plains, along their flyway, as staging and resting areas. Grain fields are frequently used for feeding. The current wild population contains about 130 individuals.

Of 48 sightings in the Souris River drainage basin, 26 were confirmed and 22 considered as probable (CWS unpublished data, 1986). Only two recent sightings of whooping cranes took place in the Souris River or Moose Mountain Creek valleys suggesting that these river valleys are not prime staging and resting habitat for this species. Whooping cranes formerly nested across southern Manitoba and over much of Saskatchewan.
The majority of migrants are still reported from central and southeastern Saskatchewan. Whooping cranes frequently rest at several wildlife refuges along their "current" migration corridor (Gollop 1978). The Rafferty and Alameda Project lies within this corridor.

10.3.1.5 Piping Plover

The piping plover is a small shore bird not much larger than a sparrow. It has never been abundant in Canada and has suffered a substantial decline over the past 30 years (Bell 1978). The Saskatchewan population was estimated at about 500 pairs in 1979 (Ouellet 1979). The piping plover in the prairie provinces breeds from central Alberta to southern Manitoba preferring sandy or pebbly beaches for nesting and foraging. The current main breeding area is in south central Saskatchewan. In Manitoba, only the southern Lake Manitoba and Winnipeg areas offer suitable nesting habitat. Past sightings of this species in Manitoba have occurred at Whitewater Lake although recent drought conditions may have precluded its frequenting this area in 1988 and 1989 (Manitoba - supplementary information). Under normal conditions local pothole and marsh areas near Whitewater lake may provide suitable habitat? In North Dakota, preferences for nesting locales are alkali lakes and subsaline, semi-permanent ponds (Bell 1978). There has been only one confirmed nesting within the Souris River Basin: a brood of two in the ash lagoon at the Boundary Dam Power Station in 1978 (Switzer

1979). During a 1989 survey the SBDA noted the presence of 4 nesting pairs on Nickle Lake, a reservoir upstream of the proposed Rafferty reservoir.

10.3.1.6 Baird's Sparrow

Baird's sparrow was recently added to the COSEWIC list in April, 1989 as a threatened species. It is a common breeder inhabiting valley bottom grasslands along the Souris River mainly northwest of McDonald Lake (Adam 1988). The species reaches its greatest densities in native and tame grasslands (Stelfox 1978) similar to habitat located in the upper portion of the proposed Rafferty Reservoir site northwest of Dr. Mainprize Park (Adam 1988). Suitable habitat also includes valley bottom haylands and croplands in what would be the main body of the Reservoir. The general prairie distribution for this species includes the southwest corner of Manitoba, however, information on specific densities along the Souris River in Manitoba is presently unavailable.

10.3.1.7 Burrowing Owl

Burrowing or ground owls occur in Canada mostly between Regina, Saskatchewan and Hanna and Lethbridge, Alberta. It prefers farm pastures and village outskirts. Their unique nesting preference for abandoned burrows and proximity to human habitation results in their continued vulnerability to poisoning with pesticides, shooting and road kills. In 1977, of the estimated 2000 pairs in Canada only 100 were found in Manitoba and about 1300 in Saskatchewan (Wedgewood 1980). The general distribution in the prairie provinces in a 1970-77 survey indicates some retraction of range, hence increasing scarcity in eastern Saskatchewan and a similar trend, but to a lesser extent, in Manitoba (Wedgewood 1978). Since considerable suitable habitat remains unoccupied, habitat loss is not the cause of the decline (Wedgewood 1980).

Six burrowing owl pairs were recorded in 1977 on the Estevan-Cambria PFRA pastures, one pair on the Lomond #1 PFRA pasture and CWS recorded four pairs on the provincial Midale pastures. A single nesting pair was recorded in 1978 at a location between Pinto and Highway #9 (Adam 1988). The SBDA suggests this observation to have been for a single bird and not a nesting pair (SBDA response to IEE 1989b). The species is more common to upland areas than the valley proper. There are no known burrowing owl nest sites above the Alameda Dam location, although one nesting site exists in the Moose Mountain Creek valley below the proposed dam (CWS, unpublished data).

Field activities conducted by the SBDA in 1984 and 1985 failed to locate breeding individuals in the Project region although they are known to be in the area (SBDA EIS 1987a).

In Manitoba, burrowing owls occur in the vicinity of the Souris River, but delineation of the exact location of nesting sites is required since much of the existing data are not current. Wedgewood (1978) provides some indication of densities in southwest Manitoba from 1970 to 1977. In Manitoba, burrowing owls have been reported from the Lyleton district in the extreme southwest (Wedgewood 1978). A 1987 sighting of two pairs of burrowing owls nesting in the broad grasslands adjacent to the Souris River in Manitoba and possibly one pair in 1989 was noted in supplementary information received from Manitoba subsequent to the public meetings. The following criteria for burrowing owl habitat were described by Wedgewood (1978):

Principal Criteria - openness of site
- availability of nest burrow
- short grass

Secondary Criteria - flat to gently undulating or sloped terrain
- largely free of boulders and brush

Tertiary Criteria - burrowing colonial mammal associates present (ground squirrels or prairie dogs)
- shelter or family dispersal holes or cavities present

10.3.1.8 Ferruginous Hawk

The ferruginous hawk is considered an uncommon breeder in the Souris valley (Adam 1988) preferring scattered shrubs and poplars on adjacent uplands as suitable nesting sites (SBDA EIS 1987a). Most observations by Adam (1987) were of single birds in the upper portion of the proposed Reservoir. Active nests were also found in the uplands east and west of Dr. Mainprize Park and north of the east end of McDonald Lake (Adam 1988). This area in the vicinity of the proposed Rafferty Reservoir is considered by Stelfox (1979) as the most easterly breeding range for this species in Saskatchewan. In 1986, scattered nests were reported in and adjacent to community pasture areas (SBDA EIS 1987a). A single pair was observed in the lower Souris River valley (Adam 1988). Approximately 20 nesting sites occur in the vicinity of the proposed Rafferty Reservoir (CWS, unpublished data).

The ferruginous hawk requires extensive (3 to 5 km^2) foraging range for small rodents, primarily ground squirrels in native and tame grasslands (SBDA EIS 1987a; Wolfinden and Murphy 1983; Schmutz, pers. comm.). Three species of ground squirrels are found in the study area. The breeding range of the ferruginous hawk does not appear to extend significantly into southwestern Manitoba, although Manitoba in supplementary information has indicated the presence of 3 to 5 nesting pairs of ferruginous hawk in the riverine grasslands between Melita and the United States boundary.

10.3.1.9 Eastern Bluebird

The eastern bluebird is a rare but confirmed breeder in the Souris valley, mostly to the east of Estevan (Adam 1988) although it has been reported downstream of both proposed reservoir sites (Young and Kerr 1989). Adult birds have been observed southwest of Oxbow, southeast of Estevan and near Glen Ewen. Breeding locations include the Moose Mountain Creek area (Young and Kerr 1989). Habitat preferences are for treed areas near grasslands or orchards, as they are primarily cavity nesters although they will nest in artificial bird boxes.

10.3.1.10 Prairie Long-Tailed Weasel

The prairie long-tailed weasel is widely distributed in southern Saskatchewan and to a lesser extent in southwestern Manitoba. It prefers the late seral stages or ecotones in close proximity to free-standing water (Gamble 1981). It is the only "threatened" furbearer in the study area and was observed during field studies by the SBDA (1987a). No individuals were observed during subsequent field studies conducted by the SBDA during 1988 and 1989 (SBDA response to IEE 1989b). No individuals were observed during subsequent field studies conducted by the SBDA during 1988 and 1989 (SBDA response to IEE 1989b).

10.3.2 North Dakota

The U.S. Army Corps of Engineers (1988) identified three protected species that may use the Souris River valley in North Dakota for feeding or resting during migration. These are the bald eagle, peregrine falcon and whooping crane. Sensitive habitat areas specific to these species or any indication of species distributions were not provided. The piping plover was identified as a breeding species in the portion of North Dakota within the Lake Darling project area. Its breeding habitat preferences were noted as sand bars and bare soil areas. Bell (1978) briefly discusses piping plover distributions in North Dakota.

10.3.3 Impacts of the Project

10.3.3.1 Introduction

The SBDA's EIS (1987a) did not provide sufficient detail in delineating the potential impacts on rare and endangered species. In part, this may have been because baseline data were fragmented and few endangered or threatened species would appear to be significantly affected by construction and operation of the Project. Species rarely seen in Project area such as the Cooper's hawk and the great gray owl are unlikely to be affected either by reservoir construction or operation. Occasional migrants such as the whooping crane and peregrine falcon should not be seriously affected by the Project except perhaps during recreational activities associated with reservoir use. Hunting might interfere with staging and resting of migrating populations in and near the reservoirs. The Souris River valley would seem to provide poor habitat for loggerhead shrike suggesting that it would tend to avoid the area. The Project is therefore unlikely to impact on this species. The adaptability of the eastern bluebird to artificial nesting boxes, its tolerance to some disturbance and its presence primarily downstream of the two reservoir sites suggests minimal and temporary impacts on this species from channel improvement work only. The following discussion on impacts will therefore concentrate on the five remaining species.

10.3.3.2 Saskatchewan

Construction

Temporary loss of habitat of the prairie long-tailed weasel might occur in the vicinity of the construction site. This species prefers ecotones close to free-standing water, and these could be directly affected. It is doubtful this disturbance would have any significant effect on the size of the weasel population in southern Saskatchewan.

Reservoir Filling

By far the greatest impact would result from land clearing and inundation of floodplain habitat. Creation and filling of the reservoirs, in particular Rafferty, could eliminate or at the least disturb preferred or potential nesting sites for ferruginous hawks. Pending the determination of their exact locations, up to four nesting sites of the ferruginous hawk could be flooded by Rafferty Reservoir. Considering the hawks extensive foraging range, a further 16 sites could be impacted (CWS, unpublished data). This would account for disturbances of about 2 percent of the known nesting sites in Saskatchewan and about 1 percent of the total in Canada (CWS unpublished data, Schmutz 1987). Surcharging the reservoir during floods above FSL to 554 meters would further increase the degree of impact on this species assuming that they continued to nest in the vicinity of the new reservoir. Such events however are anticipated to occur infrequently and only for short durations.

Supplementary information provided by the SBDA is in dispute with CWS findings regarding the number of ferruginous hawk nesting territories potentially affected by construction, filling and possible surcharging of the Rafferty Reservoir. The SBDA contends that only one nest would be directly flooded. They also imply that since some sites are "inactive" their value is diminished and hence impacts would not accrue.

Sites termed "inactive" may be unused from time to time but should not be considered abandoned. They are used as alternate sites and form an integral function for the species. The use of a 1.5 km foraging range by the SBDA further underestimates the potential influence of the reservoir.

The use of the habitat evaluation procedure (HEP) model by the SBDA also tends to underestimate the value of agricultural land as foraging habitat. Of perhaps even more importance than the agricultural land are edge values of cultivated land a fact which is not taken into account in assessing the value of foraging habitat by the SBDA.

As a result of these data discrepancies and the need for additional information on the extent and quality of foraging habitat it is difficult to accurately assess impacts on the local ferruginous hawk population. Within the foraging range of 16 nest sites, most of the area to be flooded is pasture. Since ground squirrels, an important food of hawks, prefer pasture over cultivated land, the loss of foraging opportunity could be quite substantial.

The lack of quantitative baseline data on the status of Baird's sparrow in the Rafferty-Alameda area also complicates any assessment of impact on this species. Given that the species reaches its greatest densities in ungrazed native and tame grasslands and with the knowledge that most of the area to be flooded is similar habitat (Stelfox 1978), it would be safe to assume that considerable Baird's sparrow habitat will be flooded and lost. The quality of this habitat is unknown and its productivity has not been calculated although the SBDA (1987a) indicated that numeric predictions on the Project impact on Baird's Sparrow using HEP models would receive further attention. The current status of these investigations is not known.

Based on the habitat suitability index model the SBDA predicts that preferred habitat will increase for Baird's sparrow with the purchase of mitigation lands having grass and some shrub cover. The SBDA suggests that this increase will more than mitigate for losses due to reservoir filling although no indication is provided on species densities nor their likelihood of utilizing the new habitat.

On the plus side, during the reservoir filling period, there may be some years when the reservoir levels will be relatively stable and the reservoir perimeter will provide suitable habitat for the prairie long-tailed weasel. In addition, beaches created by the reservoir might prove suitable for piping plover nesting.

Flow alterations associated with reservoir operation that result in changes in downstream wildlife habitat would not significantly affect rare and endangered vertebrate species.

Although filling of the Rafferty reservoir may result in some deviation to eastern bluebird migrations such deviations are expected to be slight. Impacts to nesting habitat can be offset through the provision of artificial nesting boxes. Additional habitat preference data for the eastern bluebird would assist in mitigating potential habitat losses, particularly information on the effect of flow regime changes on riverine wooded areas.

Downstream Habitat

Concern for the potential impact of dams on downstream riparian habitat was expressed by various respondents. The integrity of downstream riparian habitat is conditional on maintaining normal flow patterns. Any disruption such as a reduction in frequency and magnitude can result in degradation of the habitat as shown by Bradley and Smith (1986) for cottonwoods on the Milk River.

Riparian zones are invaluable to wildlife and their degradation may have some influence on such species as the eastern bluebird and the Cooper's hawk. It is therefore essential that riparian habitat in the basin be evaluated for wildlife potential, monitored and every effort made to mitigate damage.

The riparian woodlands of the Souris River Basin are dominated mostly by elm, ash and maple species which may undergo some long term effects from a reduced and changed flow regime. The eastern fox squirrel, preferring hardwood woodlands, is a newcomer to the Souris basin having extended its range from the northeastern USA. Although it appears on COSEWIC listings it has not been given an official status designation. It is considered rare in Canada but occurs in considerble numbers in the United States. Riparian hardwood habitat affected by a changing flow regime may influence the numbers of eastern fox squirrels and the rapidity of their colonization. It is doubtful that this would seriously affect squirrel populations in the basin as a whole.

Channelization

Except for possible temporary disturbances of occasional raptors and eastern bluebird nesters in the vicinity, it is doubtful that channelization along the 16 km reach of river downstream of the Rafferty Dam will cause any significant impacts to rare and endangered bird or mammal species.

Drainage of Wetlands

Concerns for drainage of wetlands associated with the Project have been dealt with adequately in the section on migratory birds. The substantial loss of wetlands over and above natural losses due to drought conditions could severely impact migrating endangered or threatened species. For example, whooping cranes depend on large wetland tracts for staging and foraging along their migration route.

10.3.3.3 North Dakota

An assessment of potential impacts to endangered and threatened species resulting from the Lake Darling one-foot raise was completed by the U.S. Army Corps of Engineers (1988). The U.S. FWS concurred that no adverse impacts would accrue to protected species or their habitat. The Rafferty-Alameda project is also not expected to have an impact on rare species in North Dakota.

10.3.3.4 Manitoba

Flood control in the U.S. would result in decreased flood peaks in the Manitoba reach, although flooding would be prolonged in lower areas. Most of the higher discharges can be accommodated with the exception of a 10 km stretch of the Souris River immediately downstream of the North Dakota-Manitoba border which has a lower channel capacity. Over-bank flooding would occur about once every 10 years. Adjacent areas are primarily agricultural land. Although localized habitat would be flooded, it would be unlikely that rare and endangered species or their prey would be affected.

10.3.4 Summary of Impacts

The ferruginous hawk population would be affected primarily by nest habitat loss and foraging losses due to reservoir filling. Burrowing owls nest primarily in upland habitats and are not expected to be affected by the Project. Beneficial impacts may be available to piping plover with the added shoreline of suitable nesting beaches. Baird's sparrow habitat will be lost in the reservoir vicinity but the extent of the impact remains unknown in the absence of additional information on species numbers and habitat preferences in Saskatchewan. In Manitoba potential changes in the duration of overbank flooding may have a very limited but presently unquantifiable effect on habitat and/or prey of one or more rare and endangered species. There do not appear to be any significant impacts in North Dakota to threatened and endangered species.

Public meetings and supplementary information provided by interested agencies following these meetings did not change the assessment of predicted impacts regarding rare and endangered species but rather helped to confirm statements made in the draft IEE and the lack of adequate baseline information for several key species on which to predict impacts. Nevertheless what is known about these species suggests that the impacts in most cases, contrary to the opinions sometimes expressed by presentors, are not significant and in most cases mitigable.

Some individuals at the public meetings erroneously assumed that all eleven faunal species noted in the IEE would be affected adversely. This is certainly not the case. Some like the whooping crane would not likely be affected at all and the piping plover might benefit from the project.

Public meetings and supplemental information supported the view that with the provision of additional baseline information, particularly in the Manitoba portion of the Souris Basin adequate mitigative measures can be developed to ensure protection of those rare and endangered faunal species designated on the COSEWIC list.

10.3.5 Mitigation

10.3.5.1 Saskatchewan

Ferruginous hawk nesting habitat lost because of reservoir filling can be mitigated through the provision of alternate or artificial nest sites for raptors. The SBDA agreed to this provision as a mitigative measure for this species at the Rafferty Dam site. In supplementary information provided by the SBDA it was proposed to erect six artificial nesting platforms. Other mitigation recommended by the SBDA is the creation of one or more ecological reserves. It may also be necessary to provide protective measures (e.g., fencing) at nesting sites. Piping plover nesting beaches can be created along the reservoir shoreline. Consideration should be given to scheduling channelization work for periods other than the spring nesting season. Some degree of mitigation can also be achieved for various species if protective measures such as the establishment of ecological reserves as originally stipulated in the rescinded IRIA licence and previously agreed to by the SBDA are initiated.

The SBDA in supplementary information states that the creation of 2237 ha of new community pastures and to a lesser extent, additional wildlife mitigation lands will provide sufficient habitat to mitigate for losses of burrowing owl habitat. Further assessment as to the suitability of these lands as habitat replacement is required.

10.3.5.2 North Dakota

Requirements for mitigation were not identified because resources used by threatened and endangered species will not be affected significantly and because critical habitats were not identified.

10.3.5.3 Manitoba

Project impacts to rare and endangered fauna in Manitoba cannot be quantitatively assessed because of data deficiencies. Further information is required on the status of burrowing owl population and nesting sites and status of prey species for ferruginous hawks.

10.3.6 Residual Impacts

10.3.6.1 Saskatchewan

Residual impacts would include loss of nest and foraging habitat for ferruginous hawks and nesting habitat losses for Baird's sparrow due to reservoir inundation.

10.3.6.2 North Dakota

None.

10.3.6.3 Manitoba

Impacts from prolonged discharges from North Dakota are unknown, but are probably not very insignificant.

10.3.7 Information Deficiencies

10.3.7.1 Saskatchewan

Information on the habitat quality of the flooded area relative to the surrounding habitat is needed in relation to nesting and foraging requirement for the ferruginous hawk, burrowing owl and Baird's sparrow. Especially data discrepancies regarding the number of affected ferruginous hawk territories, the size of foraging ranges and the value of foraging habitat require clarification. Productivity information on the ferruginous hawk is essential for monitoring the success of mitigative efforts. Quantitative baseline information is lacking on Baird's sparrow in the Souris valley and Rafferty site in particular.

10.3.7.2 North Dakota

No information deficiencies were identified by the U.S. Army Corps of Engineers.

10.3.7.3 Manitoba

Information is lacking on rare and endangered vertebrate species along the Souris River corridor in Manitoba. Of particular importance is nesting information for burrowing owls and ferruginous hawks.

10.4 Rare Plant Species

The Souris River Valley contains a large number of plant species that are rare in Saskatchewan and many will be affected adversely by the Project. These, for the most part, are at the northwest extremity of their range. They are distributed widely east and south into the eastern hardwood forests and into what remains of the former tall-grass prairie of the American Midwest. The Souris River valley, including its drainage basin as a whole, offers habitat to a number of plant species that have been defined as rare in Canada. Nineteen species of national significance have been identified, and these will be discussed in detail.

10.4.1 Saskatchewan

Table 10.2 provides a list of the rare plants located in the Saskatchewan portion of the Souris River basin with their the most common English name (Maher *et al.* 1979). *Potentilla finitima* Kohli and Packer was excluded from the list because it has recently been shown not to be rare in Saskatchewan. The recent discoveries of large-toothed Virginia creeper (*Parthenocissus inserta*) and Indian grass (*Sorghastrum nutans*) by V.L. Harms (1989a) have been included. Self-heal (*Prunella vulgaris* var. *lanceolata*) was included on the strength of V.L. Harms' view that it is worthy of recognition as a provincially rare plant.

The location where these plant species have been found are presented in Table 10.3. Much of this information was obtained from V.L. Harms' plant locality map for the Souris valley as presented in his report on the vegetation of the area around the proposed Alameda Reservoir (Environmental Management Associates 1988) . Three grass species were present at so many locations that only the number of locations is given. Table 10.4 gives the distribution of each of these species in the rest of Canada, based on

"Flora of Canada" (Scoggan 1979), "Flora of Alberta" (Moss 1983), and the "Atlas of the Rare Vascular Plants of Ontario" (Argus *et al.* 1987). From Table 10.4, it can be seen that the great majority of rare Saskatchewan plants that are represented in the Souris River valley are at the northwest extremity of their range.

Table 10.5, compiled from "Atlas of the Flora of the Great Plains" (Great Plains Flora Association 1977, 1986), reinforces this conclusion by providing the distribution in the nearby parts of the United States of the Saskatchewan rare plants. Here a word of warning may be given: the data in this publication are presented as dot maps with one dot per county and the dot placed at the centre of the county. A lot of the dots may represent old collections no longer represented by viable populations because of agriculture practices. Table 10.6 gives the habitats where these plant species are found. These habitats are derived from the personal field experience of J.H. Hudson (per. comm.), unless otherwise stated.

Table 10.2 Saskatchewan List of Rare Plants in the Souris Basin

Andropogon gerardi Vitman	Big Blue-stem
Antennaria neodioica Greene	Tomentose Pussy-paws
Asclepias syriaca L.	Silky Milkweed
Asclepias verticillata L.	Whorled Milkweed
Botrychium lunaria L.	Moon-fern
Bouteloua curtipendula (Michx.) Torr.	Side-oats Grama Grass
Buchloë dactyloides (Nutt.) Engelm.	Buffalo Grass
Carex assiniboinensis W. Boott.	Assiniboia Sedge
Carex gravida Bailey	Heavy-fruited Sedge
Carex tetanica Schkuhr	Rigid Sedge
Celastrus scandens L.	Climbing Bittersweet
Cyperus schweinitzii Torr.	Schweinitz's Cyperus
Eleocharis compressa Sulliv.	Flat-stemmed Spike-rush
Eleocharis engelmannii Steudel.	Engelmann's Spike-rush
Eragrostis hypnoides (Lam.) BSP.	Creeping Love-grass
Gentiana andrewsii Griseb. var *dakotica* A. Nels.	Bottle Gentian, Western Bottle Gentian
Helianthus tuberosus L var.*subcanescens* A. Gray	Jerusalem Artichoke
Laportea canadensis (L.) Wedd.	Wood Nettle
Lomatium orientale Coult. & Rose	White-flowered Prairie Parsley
Lotus purshianus (Bent.) Clements & Clements	Prairie Birdsfoot Trefoil
Myriophyllum pinnatum (Walt) B.S.P.	Pinnate Water-milfoil
Onosmodium molle Michx.var *occidentale* (Mack) Johnston.	Western False Gromwell
Oxytropis lambertii Pursh	Purple Loco-weed
Panicum virgatum L.	Switch-grass

Table 10.2 Saskatchewan List of Rare Plants in the Souris Basin (continued)

Panicum wilcoxianum Vasey {sometimes found under the segregate genus *Dichanthelium*}	Witch Grass, Sand Millet
Polygala alba Nuts.	White Milkwort
Polygala verticillata L.	Whorled Milkwort
Polygonatum canaliculatum (Muhl.) Pursh	Common Solomon's Seal
Prunus americana Marsh. var *americana*	American Plum
Scirpus pallidus (Britton)Fern.	Green Bulrush
Scutellaria lateriflora L.	Blue Skullcap
Sorghastrum nutans (L.) Nash	Indian Grass
Verbena hastata L.	Blue Vervain
Verbena urticifolia L	Nettle-leaved Vervain
Viburnum lentago L.	Nanny-berry
Viola pedatifida G. Don	Crowfoot Violet
Parthenocissus inserta (Kerner) K. Fritsch	Large-toothed Virginia Creeper
Pellaea glabella Mett. var. *occidentalis* (E.Nels.) Butters	Cliff-brake
Prunella vulgaris L var *lanceolata* (Barton)Fern	Self-heal, Heal-all

Table 10.3 Saskatchewan Localities of Rare Plants in the Souris Basin

Andropogon gerardi	General from Estevan down-valley to U.S. boundary. Harms mapped 22 sites.
Antennaria neodioica	Pinto
Asclepias syriaca	Roche Percée
Asclepias verticillata	Estevan
Botrychium lunaria	Wauchope (in Pipestone valley)
Bouteloua curtipendula	Fairly frequent down-valley from Hitchcock. Harms mapped 18 sites.
Buchloë dactyloides	Estevan
Carex assiniboinensis	Roche Percée, Trossachs
Carex gravida	Roche Percée, Oxbow
Carex tetanica	Carievale, Kisbey, Alameda Dam site area
Celastrus scandens	Estevan, Pinto
Cyperus schweinitzii	Roche Percée
Eleocharis compressa	Pinto, Forget, Kisbey, Oxbow
Eleocharis engelmannii	Colgate
Eragrostis hypnoides	Glen Ewen
Gentiana andrewsii	Moose Mountain Provincial Park
Helianthus tuberosus subcanescens	Goodwater, Gainsborough, Elcott, Shand, Oxbow, Roche Percée
Laportea canadensis	Estevan, Glen Ewen, Roche Percée
Lomatium orientale	Estevan, Pinto
Lotus purshianus	Carievale, Gainsborough, Bromhead, Goodwater, Elcott, Alameda Dam area
Myriophyllum pinnatum	Wordsworth
Onosmodium molle	Estevan, Gainsborough, Hirsch, Roche Percée
Oxytropis lambertii	Oxbow, Goodwater, Estevan, Roche Percée
Panicum virgatum	Oxbow, Glen Ewen, Kisbey, Estevan. Harms gave 9 stations in the area.
Panicum wilcoxianum	Goodwater, Hirsch
Polygala alba	Estevan, Shand, Oxbow, Alameda Dam area
Polygala verticillata	Estevan
Polygonatum canaliculatum	Estevan, Oxbow, Glen Ewen, Roche Percée
Prunus americana americana	Estevan, Gainsborough, Glen Even
Scirpus pallidus	Glen Ewen
Scutellaria lateriflora	Roche Percée, Estevan, Glen Ewen, Oxbow Elcott
Sorghastrum nutans	Pinto
Verbena hastata	Roche Percée
Verbena urticifolia	Gainsborough
Viburnum lentago	Pinto
Viola pedatifida	Estevan, Arcola, Pinto, Portal, Wordsworth
Parthenocissus inserta	Oxbow, Roche Percée
Pellaea glabella occidentalis	Roche Percée
Prunella vulgaris lanceolata	Oxbow, Shand, Alameda Dam area

Table 10.4 Canadian Distribution of Saskatchewan Rare Plants from the Souris Basin

Andropogon gerardi	Sask: Qu'Appelle Valley; southern 1/3 Manitoba, S. Ontario, S.W. Quebec
Antennaria neodioica	Sparsely across Canada from N.S. to B.C.
Asclepias syriaca	Eastern; southern Man., S. Ont., S. Que. the Maritimes
Asclepias verticillata	S. Manitoba & extreme S. Ont.
Botrychium lunaria	Transcontinental and circumboreal
Bouteloua curtipendula	S. Man., S. Ont. very rare; few stations in Qu'Appelle Valley, Sask.
Buchloë dactyloides	Coulter - only in Man.
Carex assiniboinensis	Qu'Appelle & Red Deer valley in Sask; S. Man.
Carex gravida	Rare, extreme S.W. Ont.; also Willowbunch, Sask.
Carex tetanica	a few other stations in S.E. Sask.; S. Man., S. Ont.
Celastrus scandens	East to S. Man., S. Ont., S.W. Que.
Cyperus schweinitzii	A few stations in S.E. Alta., S. Sask., S.W. Man.; east to S. Ont., S.W. Que.
Eleocharis compressa	A few stations in S. Man., E. to S. Ont.
Eleocharis engelmannii	Western: Granum, Alta.; Killarney, Man.; fair number of Sask stations - 7.
Eragrostis hypnoides	Eastern; S. Man. to S. Ont., S.W. Que.
Gentiana andrewsii dakotica	This variety in S. Man.; var *andrewsii* in S. Ont. & S.W. Que.
Helianthus tuberosus subcanescens	East to S. Man., S. Ont., S. Que.
Laportea canadensis	East to S. Man., S. Ont., S. Que., N.B., N.S.
Lomatium orientale	Only Man. also; 4 stations in White & Johnson, all along Souris R. valley
Lotus purshianus	S. Man.; material from S.W. B.C. may be a different subspecies
Myriophyllum pinnatum	Not elsewhere in Canada
Onosmodium molle occidentale	Alberta foothills from Calgary south; S. Man.; 2 Qu'Appelle valley sites, Sask.
Oxytropis lambertii	S. Man.; a few Qu'Appelle valley stations in Sask.; not in Alta., acc to Argus & White
Panicum virgatum	Eastern, S. Man., Old Ontario, S.W. Que.
Panicum wilcoxianum	Fort Sask., Alta.; 3 other stations in Sask.; 7 stations in Man. known in 1980
Polygala alba	Only in Big Muddy Valley, Sask.
Polygala verticillata	Yarbo, Sask.; 5 stations in Man. in 1980; S. Ont., S.W. Que.
Polygonatum canaliculatum	Eastern; S. Man., S. Ont., S.W. Que.

Table 10.4 Canadian Distribution of Saskatchewan Rare Plants from the Souris Basin (Continued)

Prunus americana americana	Eastern, S. Man., S. Ont., S.W. Que.
Scirpus pallidus	Edmonton & Medicine Hat, Alta. (Packer); 2 Qu'Appelle Valley stations, Sask., S. Man., Ont., S. Que., & Eastward
Scutellaria lateriflora	Temperate transcontinental, lacking in Alta. & W. Sask.
Sorghastrum nutans	Eastern; S. Man., S. Ont., & S.W. Que.
Verbena hastata	Temperate transcontinental, lacking in Alta. & W. Sask.
Verbena urticifolia	Absent in Man.; eastern, S. Ont., S. Que. N.B.
Viburnum lentago	Eastern; southern quarter of Man., S. Ont., S.W. Que.
Viola pedatifida	S. half of Man.; Packer & Bradley give 5 locations in central Alta. parklands; 18 locations in S.E. and S.C. Sask., many of them old; Argus & White (Atlas Ont) imply its absence in Ont.
Parthenocissus inserta	Eastern; S. Man., temperate Ont.
Pellaea glabella occidentalis	Western; Rocky Mtns. of Alta. & S.W. Mackenzie; a few stations on limestone in N. Sask. and Paleozoic belt of Man.; Big Muddy Valley, Sask.
Prunella vulgaris lanceolata	Transcontinental, gap from eastern Sask. to western Alta.

Table 10.5 United States Distribution of Saskatchewan Rare Plants from the Souris Basin

Andropogon gerardi	Seems abundant, N.D. and Southward.
Antennaria neodioica	Not segregated from *A neglecta* in Atlas Fl. GP. but separated in text - no statements on abundance there.
Asclepias syriaca	Well represented, east N.D. and southward.
Asclepias verticillata	Well represented, N.D. and southward
Botrychium lunaria	Rare Burke and McHenry cos. N.D.
Bouteloua curtipendula	Seems frequent, N.D. abundant south to Kansas.
Buchloë dactyloides	Not so common Souris Valley of N.D., commoner southward. Rare or absent, northern part of N.D.
Carex assiniboinensis	Rather rare-few stations. northeast N.D. west Minn, east S.D.,northwest Iowa.
Carex gravida	Fair scattering stations N.D. to Kansas.
Carex tetanica	Scattered stations, N.D. between Missouri and Red Rivers south to Nebraska.
Celastrus scandens	Fair scattering of stations in N.D., more further south.
Cyperus schweinitzii	Few stations in N.D., more in Kansas and Nebraska.
Eleocharis compressa	Scattered stations N.D. more further south.
Eleocharis engelmannii	A scattering of stations in N.D. thicker in Kansas and MO.
Eragrostis hypnoides	Some stations, east N.D. evidently common only east fringe of Great Plains.
Gentiana andrewsii dakotica	Fair number of stations east N.D, west Minn, rather rare southward.
Helianthus tuberosus subcanescens	Seems reasonably abundant, north N.D. and southward.
Laportea canadensis	Evidently eastern, stations only on the east edge of the Great Plains.
Lomatium orientale	Fair scattering of stations, N.D. to Kansas.
Lotus purshianus	Common, N.D. and southward.
Myriophyllum pinnatum	Two stations S.D., centre of population on Great Plains in Kansas and Mo.
Onosmodium molle occidentale	Common N.D. to Kansas.
Oxytropis lambertii	Common, N.D. and Montana southward.
Panicum virgatum	Common, N.D. and southward
Panicum wilcoxianum	Fairly frequent, N.D. and Nebraska.
Polygala alba	Frequent, N.D., Montana and southward.
Polygala verticillata	Sporadic, N.D., more frequent eastward and southward.
Polygonatum canaliculatum	Frequent, N.D. eastward to southward.

Table 10.5 United States Distribution of Saskatchewan Rare Plants from the Souris Basin (continued)

Prunus americana americana	Frequent N.D. southward.
Scirpus pallidus	Common, N.D. to Kansas.
Scutellaria lateriflora	Many reports, eastern N.D. eastward and southward.
Sorghastrum nutans	Infrequent, N.D. (Stevens), commoner southern N.D. and southward.
Verbena hastata	From N.D. frequent to east and south.
Verbena urticifolia	Only east N.D., frequent MO and Kansas and probably eastward.
Viburnum lentago	Evidently eastern in distribution, fair scattering in N.D., few reports southward except edge Great Plains.
Viola pedatifida	Evidently American midwest, reports concentrated on east part of Great Plains
Pellaea glabella occidentalis	Southwest N.D., east Wyo.
Parthenocissus inserta	Fairly abundant, N.D. and south.
Prunella vulgaris lanceolata	Scattered, Red River valley, more abundant further south; text says the European variety vulgaris has not been seen in Great Plains.

Note: Records from maps in Atlas of the Flora of the Great Plains; many locality citations are apt to be old and not now represented by populations due to agricultural spread.

Table 10.6 Habitat of Saskatchewan Rare Plants from the Souris Basin

Andropogon gerardi	Moist prairie (a tall-grass prairie species).
Antennaria neodioica	Moist prairie, sparsely vegetated ground.
Asclepias syriaca	River bank.
Asclepias verticillata	Dry wash slopes (alluvial pediments) below bedrock outcrops.
Botrychium lunaria	Open poplar woods on sandy soil.
Bouteloua curtipendula	Moist prairie (a tall-grass prairie species).
Buchloë dactyloides	Clay flats, occasionally inundated so that climax prairie is drowned out.
Carex assiniboinensis	Hardwood forests on river bottoms.
Carex gravida	Hardwood forests on river bottoms.
Carex tetanica	Ground water fed bogs, ground water discharge areas.
Celastrus pscandens	Shrubby river bluffs.
Cyperus schweinitzii	Sandy soil, disturbed sands in sand hill areas.
Eleocharis compressa	Low producibility calcareous ground water discharge areas.
Eleocharis engelmannii	Ephemeral sloughs in tilled fields.
Eragrostis hypnoides	Mud flats on river banks or abandoned river oxbows.
Gentiana andrewsii dakotica	"Moist prairies" (Maher el al.)
Helianthus tuberosus subcanescens	River banks.
Laportea canadensis	Wet shady spots on wooded river flood plains.
Lomatium orientale	Dry benches along valleys.
Lotus purshianus	Dry slopes along valleys.
Myriophyllum pinnatum	A slough. Report old, circa 1938. Chance introduction? Way out of range.
Onosmodium molle occidentale	Brushy river banks.
Oxytropis lambertii	Moist slopes.
Panicum virgatum	Moist prairie (a tall-grass prairie species).
Panicum wilcoxianum	Sandy prairie in parkland areas.
Polygala alba	Dry eroded slopes, till or bedrock.
Polygala verticillata	Gravelly knolls or clayey wash slopes.
Polygonatum canaliculatum	Under hardwood forest on floodplains.
Prunus americana americana	Floodplain-forests.
Scirpus pallidus	Hillside ground water seeps on wooded slopes.
Scutellaria lateriflora	Wet ground, slough or river margins.
Sorghastrum nutans	"Moist prairie" (a tall-grass prairie species).

Table 10.6 **Habitat of Saskatchewan Rare Plants from the Souris Basin (continued)**

Verbena hastata	Moist ground or valley bottoms.
Verbena urticifolia	River banks - it was the Antler River.
Viburnum lentago	Floodplain-forest.
Viola pedatifida	Moist prairie.
Pellaea glabella occidentalis	Cliffs of calcareous rocks.
Parthenocissus inserta	Floodplain-forests.
Prunella vulgaris lanceolata	Moist ground.

Note: Habitats are from the J.H. Hudson's personal field books except those in quotes which are from floras.

10.4.2 North Dakota

A list of the rare plants from the North Dakota portion of the Souris River Basin is presented in Table 10.7. These plant species have been identified under the natural Heritage Program of the North Dakota Parks and Recreation Department as rare or unique in North Dakota. These species have been documented for the Souris Basin.

The Rafferty Alameda Project is not expected to greatly affect abundance of rare plant species in North Dakota because flow in much of the Souris River is already regulated by Lake Darling and the National Wildlife Refuges. However, the reduced frequency of occurrence of significant overland flooding could affect some species. Additional studies are required to determine the impact of the Project on plant communities and species in North Dakota.

Limited information is found in the Atlas of the Flora of the Great Plains (Great Plains Flora Association 1977) and Stevens (1950). It is expected the majority of rare plants in North Dakota would be at the northern limit of distribution for populations that occur further south.

10.4.3 Manitoba

Table 10.8 to 10.12 present similar lists for the rare plants found in the Souris River basin of Manitoba. As the majority of the rare species of southwestern Manitoba also occur in Canada further west in Alberta and Saskatchewan, much of the information presented in Table 10.8 to 10.12 was derived from two Alberta rare-plant lists (Argus and White 1978, and Packer and Bradley 1984).

Table 10.7 North Dakota List of Rare Plants in the Souris Basin

Botrychium matricariaefolium	Grape Fern
Salix pedicellaris	Bog Willow
Carex brunnescens	Brownish Sedge
Spiranthes romanzoffiana	Continental Ladies-tresses
Oenothera lacinata	Outleaf Evening Primrose
Thelesperma subnudum	Greenthread
Carex capillaris	Hair-like Sedge
Thelypteris palustris	Marsh Fern
Carex gynocrates	Pistillate Sedge
Suckleya suckleyana	Poison Suckleya
Carex backii	Back's Sedge
Carex richardsonii	Richardson's Sedge
Juncus brevicaudatus	Short-tailed Rush
Acrous americanus	Sweet Flag
Elatine triandra	Waterwort
Cypripedium calceolus	Yellow Lady's Slipper
Galium labradoricum	Bog Bedstraw
Menyanthes trifoliata	Buckbean
Utricularia intermedia	Flat-leaved Bladderwort
Utricularia minor	Lesser Bladderwort
Carex limosa	Mud Sedge
Wollfia columbiana	Wolffia
Eleocharis pauciflora	Few-flowered Spikesedge
Pilea fontana	Clearweed
Potentilla palustris	Purple Cinquefoil
Carex Pseudocyperus	False Cyperus Sedge
Carex leptalea	Delicate Sedge
Ranunculus flammula	Acrid Spearwort
Penstemon procerus	Littleleaf Penstemon
Ambrosia acanthicarpa	Annual Burage
Carex scirpiformis	Bulrush Sedge

Source: List prepared by North Dakota Parks and Recreation Department

A number of individuals pointed out during the Public Meetings that some of the rare plant species identified herein are also listed in the "Schedule Of Weeds Which May Be Declared Noxious By The Lieutenant Governor in Council which is in **The Noxious Weeds Act** of Manitoba. The species that are listed in the Act and in this IEE include: silvery atriplex, golden-bean, witch grass, spatulate-leaved heliotrope, whorled milkweed, winged pigweed, and wavy-leaved thistle. Clearly, the inclusion of rare plant species in **The Noxious Weeds Act** of Manitoba is inconsistent with the principles and philosophy of the conservation and protection of rare species.

The governments of Manitoba and Canada equally participate in the identification and protection of rare species. Environment Canada recommends that the Noxious Weeds Act be amended to include only those species that affect agricultural production or natural plant communities in Manitoba.

Table 10.8 Manitoba List of Rare Plants in the Souris Basin

Asclepias verticillata L.	Whorled Milkweed
Amaranthus tuberculatus (Moq.) Sauer= *Acnida tamariscina* (Nutt.) Wood.	Water Hemp.
Ambrosia acanthicarpa Hook.	Bur-ragweed.
Andropogon hallii Hack.	Hall's Bluestem
Aristida longiseta Steud.	Red Three-awn.
Arnica fulgens Pursh	Shining Arnica
Atriplex argentea Nutt.	Silvery Atriplex
Boltonia asteroides (L.) L'Her, var. *recognita* (Fern. & Grisc.) Cronq.	Boltonia.
Buchloë dactyloides (Nutt) Engelm.	Buffalo Grass.
Cirsium undulatum (Nutt) Spreng.	Wavy-leaved Thistle.
Coryphantha vivipara (Nutt.) Britton and Brown= *Mamillaria vivipara* (Nutt) Haw.	Purple Cactus.
Cycloloma atriplicifolium (Spreng.) Coult.	Winged Pigweed.
Cyperus strigosus L.	Straw-colored Nutgrass.
Cypripedium candidum Muhl.	Small White Lady's-slipper.
Euphorbia geyeri Engelm.	Prostrate Spurge.
Heliotropium curassavicum L.	Spatulate-leaved Heliotrope.
Lomatium orientale Coult. & Rose	White-flowered Prairie Parsley.
Malaxis monophyllos (L) Sw. var *brachypoda* (Gray) Morris and Eames	Adder's-Mouth.
Mertensia lanceolata Pursh	Lance-leaved Lungwort.
Microseris cuspidata (Pursh) Schultz-Bip.	Prairie False Dandelion.
Mimulus glabratus H.B.K. var *fremontii* (Benth.) Grant.	Small Yellow Monkey-flower.
Myosurus mimimus L.	Least Mouse-tail.
Orobanche ludoviciana Nutt.	Broom-rape.
Oryzopsis hymenoides (R.&S.) Ricker	Indian Rice-grass.
Panicum wilcoxianum Vasey	Sand Millet; Witch Grass.
Plagiobothrys scouleri (H.&A.) Johnst.	Scouler's *Allocarya* Rock Popcorn Flower (a misnomer).
Plantago elongata Pursh ssp. *elongata*	Linear-leaved Plantain.
Polanisia dodecandra (L.) D.C.	Clammy-weed.
Polygala verticillata L.	Whorled Milkwort.
Potentilla finitima Kohli & Packer.	No English name; could be translated as "Nearly Akin Cinquefoil"
Potentilla gracilis Dougl. var. *flabelliformis* (Lehm.) Nutt.	Fan-shaped Cinquefoil.
Potentilla plattensis Nutt.	Low Cinquefoil.
Schedonnardus paniculatus (Nutt.) Trel.	Tumble Grass.
Thermopsis rhombifolia (Nutt) Richards.	Golden Bean.
Townsendia exscapa (Richards) Porter	Low Townsendia.
Tradescantia occidentalis (Britt) Smyth	Western Spiderwort.

Table 10.9 Manitoba Localities of Rare Plants in the Souris River Basin

Amaranthus tuberculatus	Banks of Souris River, year 1889, somewhere near Melita.
Ambrosia acanthicarpa	Grande Clarière
Andropogon hallii	Aveme, Grande Clarière (2 dots)
Aristida longiseta	Brandon, Treesbank (Wh. & J.); Aveme and Treesbank (Scoggan)
Arnica fulgens	Broomhill to Medora to Brandon; Bede, Melita
Atriplex argentea	Melita
Boltonia asteroides	Melita
Buchloë dactyloides	Coulter
Cirsium undulatum	"Souris River". Not in Scoggan. Somewhere near Coulter by map.
Coryphantha/Mamillaria vivipara	Lauder, Grande Clarière
Cycloloma atriplicifolium	Grande Clarière, Aveme (Scoggan)
Cyperus strigosus	Wawanesa, 1932. See Boivin Fl. Pr. Prov., Vol IV
Cypripedium candidum	4 miles south of Brandon; Aveme (Scoggan)
Euphorbia geyeri	Grande Clarière
Heliotropium curassavicum	Lyleton, Deleau, Medora, Whitewater, Boissevain
Lomatium orientale	Souris County (1889), Souris River 20 miles south Brandon, Aveme, Coulter
Malaxis monophyllos	Treesbank
Mertensia lanceolata	Lyleton. Scoggan (1957) does not report it; neither does Boivin (1972)
Microseris cuspidata	Souris River south of Brandon
Mimulus glabratus fremontii	Shilo area - just outside region located. But Scoggan says "Aveme"
Myosuros mimimus	Old Souris River channel south of Melita, two locations Melita area (Wh & J)
Orobanche ludoviciana	Aveme, Lauder, Oak Lake
Oryzopsis hymenoides	Judging by map, Aveme or Treesbank
Panicum wilcoxianum	Going by map, Coulter area, Aveme, Grande Clarière
Plagiobothrys scouleri	Melita
Plantago elongata	Melita
Polanisia dodecandra	Aveme (two spots on map)
Polygala verticillata	Griswold (not strictly in Souris basin)
Potentilla finitima	Carberry (not quite in Souris basin)
Potentilla gracilis flabelliformis	Napinka
Potentilla plattensis	Napinka

Table 10.9 Manitoba Localities of Rare Plants in the Souris River Basin (continued)

Schedonnardus paniculatus	Melita, Medora
Thermopsis rhombifolia	Lyleton, Melita, Tilston, "1st crossing Souris River" = Coulter
Townsendia exscapa	Aweme, Brandon
Tradescantia occidentalis	15 miles N.E. of Melita = near Grande Clarière

Table 10.10 Canadian Distribution of Manitoba Rare Plants from the Souris Basin

Amaranthus tuberculatus	Eastern, south Ontario and S.W. Quebec
Ambrosia acanthicarpa	Western; Milk River, Manyberries, Empress, Alberta; scarce, Brown Soil Zone, Sask.
Andropogon hallii	Absent further west; only introduced in eastern Canada
Aristida longiseta	Western; south B.C.; south Alberta (two locations); Val Marie, Sask.
Arnica fulgens	Western; S.E. B.C.; Alta north to Fairview; not uncommon in wet years, south and central Sask.
Atriplex argentea	Western; S.E. B.C., south Alta, common S.W. Sask. and occasional central Sask.
Boltonia asteroides	Red River valley, Man; S.E. Sask. east of Missouri Coteau and south of 50° N.
Buchloë dactyloides	Elsewhere, only Estevan, Sask.
Cirsium undulatum	Western; S. B.C., S. Alta; S.W. Sask.
Coryphantha vivipara	Western; S. Alta, S.W. Sask.
Cycloloma atriplicifolium	South Ontario only
Cyperus strigosus	Watrous, Sask.; south Ont. and S.W. Que.
Cypripedium candidum	Rare in Canada; one old record, Indianhead, Sask; Woodlands, Man; five records south Ontario
Euphorbia geyeri	Rare in Canada, Manitoba only
Heliotropium curassavicum	Western; S. Alta; fairly frequent S.W. and central Sask.
Lomatium orientale	Only Sask. also, lower Souris River valley
Malaxis monophyllos	Transcontinental in more southerly parts of Boreal Forest, uncommon
Mertensia lanceolata	Only in S. Sask; Wood Mountain and Big Muddy and Souris River valleys
Microseris cuspidata	two citations, Milk River valley, S. Alta; six citations, S.C. Sask
Mimulus glabratus	Lower Qu'Appelle valley, Sask; three citations, Ont; adjacent Que
Myosurus mimimus	Rare, S. Alta; not uncommon, S.W. and W. central Sask; rare in S. Ont
Orobanche ludoviciana	Western; S. B.C., S. Alta, fairly frequent, S.W. and W. central Sask
Oryzopsis hymenoides	Western; S. B.C., S. Alta; fairly frequent, S.W. and central Sask
Panicum wilcoxianum	four citations, Aspen parkland of Sask; Ft. Saskatchewan in Alta
Plagiobothrys scouleri	Western; S. B.C., S. Alta, abundant prairie part of Sask

Table 10.10 Canadian Distribution of Manitoba Rare Plants from the Souris Basin (continued)

Plantago elongata	Western; S. interior of B.C., S. Alta, occasional, S. & W. Central Sask
Polanisia dodecandra	S. B.C., S. Alta, S. Sask, S. Ont, S.W. Que
Polygala verticillata	Eastern; Estevan and Yarbo, Sask; S. Ont, S.W. Que, four other locations, S. Man
Potentilla finitima	Western; in both rare Alta lists for S. Alta; in Sask list but not really rare, prairie Sask
Potentilla gracilis var. *flabelliformis*	Western; S.E. B.C., S. Alta, S. & W. central Sask
Potentilla plattensis	Western; S. Alta; not uncommon, S.W. and W. central Sask
Schedonnardus paniculatus	Western; rare, S.E. Alta, in both rare lists; S. Sask, not common even if not in Sask list
Thermopsis rhombifolia	Western; Alta, common in prairie Sask, four other citations, Man
Townsendia exscapa	Western; S.E. B.C., Alta; occasionally found, S.W. and W. central Sask
Tradescantia occidentalis	Manitoba only; Routledge

Table 10.11 Central United States Distribution of Manitoba Rare Plants from the Souris Basin

Amaranthus tuberculatus	Rare in N.D., commoner further S.E.
Ambrosia acanthicarpa	Rare N.D., commoner only a long way south, as southwest Kansas
Andropogon hallii	Common, southwest N.D., one county in Mouse River valley (McHenry Co.)
Aristida longiseta	Common southwest N.D. and southward
Arnica fulgens	Many reports west N.D., rare further S.
Atriplex argentea	Common, N.D. and south
Boltonia asteroides recognita	Rare N.D. and S.D., commoner further southeast
Buchloë dactyloides	Moderately abundant west N.D., abundant Kansas
Cirsium undulatum	Abundant, N.D. and south
Coryphantha [Mamillaria] vivipara	Frequent, N.D. and south
Cycloloma atriplicifolium	Rare N.D., commoner southward
Cyperus strigosus	Absent, N.D.; common Nebraska and eastward
Cypripedium candidum	Rare N.D., only few citations further southward and eastward
Euphorbia geyeri	Not common, N.D. or southward
Heliotropium curassavicum	A few reports central N.D., very scattered southward
Lomatium orientale	A fair number of stations N.D. and southward
Malaxis monophyllos brachypoda	Absent, N.D. and southward
Mertensia lanceolata	In a narrow band from W. N.D. southward
Microseris cuspidata	Scattered N.D. commoner southward
Mimulus glabratus fremontii	Rare, N.D.
Myosurus mimimus	Rare N.D., commoner southward
Orobanche ludoviciana	Scarce, N.D. and southward
Oryzopsis hymenoides	Common, west N.D. and south
Panicum wilcoxianum	Fairly common, east N.D., peters out southward
Plagiobothrys scouleri	Fair number of reports, west N.D., scarce further south, ranges westward rather
Plantago elongata	Scarce, N.D. and south
Polanisia dodecandra	Common, N.D. and south
Polygala verticillata	Fair scattering N.D., commoner southward and eastward
Potentilla finitima	Not treated by American authors
Potentilla gracilis flabelliformis	Not treated separately from *P. gracilis gracilis* in Atlas of the Flora of the Great Plains
Potentilla plattensis	Rare west N.D., lacking further south. Rare Montana

Table 10.11 Central United States Distribution of Manitoba Rare Plants from the Souris Basin (continued)

Schedonnardus paniculatus	Common N.D., abundant further south
Thermopsis rhombifolia	Fairly common west N.D., not given for Mouse River valley
Townsendia exscapa	Rare west N.D., more citations further S.
Tradescantia occidentalis	Rare, Mouse River side of N.D., commoner southward

Table 10.12 Habitat of Manitoba Rare Plants from the Souris Basin

Amaranthus tuberculatus	"Sandy shores" Probably extinct, may have been just a casual introduction in early days
Ambrosia acanthicarpa	Disturbed, open, or moving sand
Andropogon hallii	"Dry prairies and sandhills"
Aristida longiseta	Dry hot south facing slopes
Arnica fulgens	Low spots on till prairie
Atriplex argentea	Saline flats, burn-out flats, pre-glacial outcrops and the wash slopes (pediments) below them
Boltonia asteroides	Damp but not saline clay flats
Buchloë dactyloides	Clay flats, occasionally inundated so that climax prairie is drowned out
Cirsium undulatum	Dry warm slopes, mostly till
Coryphantha/Mamillaria vivipara	Sandy prairie or dry warm slopes
Cycloloma atriplicifolium	"Sandy places"
Cyperus strigosus	"Wet meadows and shores"
Cypripedium candidum	Upper most lime bearing parts of ground water outcrops; at least that's what Fletcher's field notes mean, Ott. Nat. 16(11), 221,(1903)
Euphorbia geyeri	"Active sand dunes"
Heliotropium curassavicum	Around saline lakes, particularly on sandy soil
Lomatium orientale	Dry benches along valleys
Malaxis monophyllos	Black spruce muskeg
Mertensia lanceolata	Dry prairie
Microseris cuspidata	Warm slopes in sheltered ravines
Mimulus glabratus fremontii	Cold flowing brooks, spring-fed
Myosurus mimimus	Dried out bottoms of ephemeral sloughs in farmland
Orobanche ludoviciana	Parasitic on *Artemisia campestris* on sandy prairie
Oryzopsis hymenoides	Disturbed, bare, or unstable sand
Panicum wilcoxianum	Sandy prairie in park country
Plagiobothrys scouleri	Bare dried out slough bottoms, often in farmed land
Plantago elongata	Partly salinized clay flats, burn-out clay flats, alluvial slopes below buttes
Polanisia dodecandra	Loose or disturbed sand in hot locations
Polygala verticillata	Gravelly knolls or clayey wash slopes
Potentilla finitima	Sandy prairie
Potentilla gracilis flabelliformis	Dry part of calcareous zone of ground water outcrops
Potentilla plattensis	Wetter part of calcareous zone of ground water outcrops

Table 10.12 Habitat of Manitoba Rare Plants from the Souris Basin (continued)

Schedonnardus paniculatus	Alluvial slopes below buttes, burn-out flats, clay flats in Marine Shale outcrop areas
Thermopsis rhombifolia	Prairie, especially on light soil
Townsendia exscapa	Dry sandy prairie
Tradescantia occidentalis	"Sandy places"

Note: Habitats without quotations are from J.H. Hudson's field books; those in quotes are from White and Johnson (1980).

10.4.4 Souris Valley Plants Rare to Canada as a Whole

The foregoing discussion presented the provincially rare species of plants found in the Souris River basin, their names, localities of occurrence, general distribution in Canada and the adjacent United States, and habitats. These are mainly of provincial interest.

The following discussion considers in more detail those plant species which are of both provincial and national interest. All of these species are rare in Canada. This evaluation of rare status for most species was taken from Argus and Pryer (1986) and Argus, (pers. comm.).

The rare plants of both provincial and national significance are presented below, with locations in the Souris valley and habitat.

Andropogon hallii Hack. (Hall's bluestem). Manitoba only - Aweme, Grande Clariere in Souris Valley basin, elsewhere at St. Lazare, sand dune areas and dry sandy soil. Canadian Priority 5 (Argus and Pryer 1989).

Aristida longiseta Steud (Red three-awn). Aweme and Treesbank, Manitoba; Val Marie, Saskatchewan; St. Kilda and Lethbridge, Alberta; Medicine Hat, Alberta (unpublished). Dry hot south facing slopes.

Asclepias verticillata L. (Whorled milkweed). Estevan, Saskatchewan; Red River valley, Manitoba - not in Manitoba rare plants list; rare, extreme southern Ontario. Disturbed clay flats and clayey wash slopes from bedrock outcrops.

Bouteloua curtipendula (Michx.)Torr. (Side-oats grama grass) Craven and Crooked Lake in the Qu'Appelle valley; all along the Souris River valley in Saskatchewan; not in the Manitoba rare plants list; rare in southern Ontario, a few localities. Canadian Priority 2 of Argus and Pryer (1989).

Buchloë dactyloides (Nutt.) Engelm (Buffalo grass). Estevan, Saskatchewan; Coulter, Manitoba. Clay flats, subsaline in places, or clayey depressions catching water often enough that climax prairie gets drowned out. Canada Priority 4 of Argus and Pryer (1989).

Carex gravida Bailey (Heavy-fruited sedge). Roche Percee, Oxbow, Willowbunch, Saskatchewan; rare, extreme southwestern Ontario. Hardwood forests on river bottoms, i.e. floodplain-forests. Canada Priority 2. Manitoba reports conflicting; should be found in Manitoba, but an Otterburne collection was revised to *C. alopecoidea*.

Carex tetanica Schkuhr, (Rigid sedge) including *C. meadii* Dewey, which cannot be separated in Canadian (Boivin, 1979). Saskatchewan: Carievale, Kisbey, Alameda dam area, Saltcoats, Strawberry Lakes; old Macoun records from Spy Hill and File Hills: a few stations in southern Manitoba and southern Ontario. In calcareous ground water discharge areas, often boggy. Argus and Pryer gave Canadian Priority 3 to *C. tetanica* and Priority 2 to C.*meadii*.

Cypipedium candidum Muhl (Small white lady's-slipper). One old record for Indian Head, Saskatchewan; Aveme and four miles south of Brandon, Manitoba; a few stations in southern Ontario. Apparently in the grassy drier upper zone of the discharge areas of calcareous ground water. Rated "endangered" on the COSEWIC (1988) list. Canadian Priority 1.

Eleocharis engelmannii Steud (Engelmann's spike-rush). Sometimes appears under the names E.*ovata* (Roth) R. & S. or E.*obtusa* (Willd). Schultes. In Souris basin at Colgate, Saskatchewan; Killarney, Manitoba; Granum, Alberta, also. In the writer's experience, not uncommon in the prairie regions of Saskatchewan; if one knows where to seek it. In summer-dry slough bottoms in tilled fields which had been too wet to sow in spring. Canadian Priority 2.

Euphorbia geyeri Engelm. (Prostrate spurge). Sometimes placed in the segregate genus *Chamaesyce*. Region around Grande Clarière, Manitoba; sole for Canada. Disturbed or semi-stable sand dunes. Canadian Priority 4.

Gentiana andrewsii Griseb. var *dakotica* G. Nels. (Jerusalem artichoke). Tantallon and Moose Mountain Provincial Park, Saskatchewan; old record for Zeneta, Saskatchewan. As for Manitoba, White and Johnson (1980) did not place it on their rare list; but Gillett (1963) gave six locality dots in Manitoba between Dauphin and its southeast corner, none of which were in the Souris basin. Southern Ontario and southwest Quebec material belongs to var. *andrewsii*; a separation into two varieties is not recognized by all authors. Habitat reported as wet meadows; said to be extremely rare in South Dakota by Van Bruggen (1976).

Lomatium orientale Coult. and Rose (White-flowered prairie parsley). Only Souris River valley in Canada; Estevan and Pinto in Saskatchewan; Coulter, Souris River 30 km south of Brandon, Aweme, and "Souris County" in 1889, in

Manitoba. Dry benches (terraces) along the valley in the writer's experience. Canadian Priority 4.

Microseris cuspidata (Pursh) Schultz-Bip. (Prairie false dandelion). May be found listed under the genera Nothocalais or Agoseris. Alberta - two citations from the Milk River valley; Saskatchewan - Boundary Plateau, Old Wives Lake, Mortlach, Lumsden, Lebret, Big Muddy Lake; Manitoba - Brandon, Souris River south of Brandon. Warm slopes in sheltered ravines. Canadian Priority 4.

Mimulus glabratus H.B.K. var. fremontii (Benth.) Grant (Small yellow monkey-flower). Saskatchewan - Whitewood, Round Lake, Welby; Manitoba - Shilo (White and Johnson, 1980), Aweme (Scoggan, 1979). Three stations in eastern Ontario. In cold flowing springs, preferably shaded. Canadian Priority 3.

Panicum wilcoxianum Vasey (Witch grass). Sometimes placed in the segregate genus Dichanthelium. Fort Saskatchewan, Alberta; Goodwater, Welby, MacDowall, Nisbet Provincial Forest, Togo (unpublished) Saskatchewan; Lyleton, Aweme, Grande Clarière, St. Lazare, Manitoba. Sandy prairie in parkland country. Canadian Priority 4.

Pellaea glabella Mett. var occidentalis (E. Nels.) Butters. (Smooth cliff-brake). (Sometimes as var. nana (Richards) Cody). Nahanni Range and Franklin Mountains, N.W.T.; Banff, Alberta; Carswell Lake, Clearwater River, Deschambault Lake, Amisk Lake, Big Muddy Valley, Roche Percée, Saskatchewan; Athapapuskow Lake, Grand Rapids, The Pas, Stony Mountain, Manitoba. See Rigby and Brittain (1970). On cliffs of limestone, dolomite, or limy sandstone.

Polygala alba Nutt. (White milkwort). Only in Saskatchewan: Big Muddy Valley, Estevan, Shand, Alameda dam district on Moose Mountain Creek. Dry eroded or stony knolls and slopes, indifferently on till or bedrock. Canadian Priority 5.

Schedonnardus paniculatus (Nutt.) Trel. (Tumble grass). Medicine Hat to Manyberries, Alberta; Mortlach, Herbert, Plato, Altawan, Old Wives Lake, Eagle Creek, Moose Jaw, Swift Current, Val Marie, Saskatchewan - quite a few places but never very much of it is found at any locality; Melita and Medora, Manitoba. Dry and subsaline or burn-out flats, alluvial slopes below buttes, clayey valley bottoms in areas of thin till over Marine Shale, clay flats occasionally flooded and thus without climax mixed prairie nearby.

Tradescantia occidentalis (Britt.) Smyth (Western spiderwort). Near Grande Clarière, and Routledge, Manitoba. Apparently very sandy prairie or semi-stablized sand dunes. Canadian Priority 4. Argus and Pryer (1989) mention an Alberta occurrence which no other writer does.

10.4.5 Impacts on Plants of National Interest

This section discusses impacts, both immediate and long-term, of the Project on the plant species of national interest listed above. Information sources consulted in this section include Harms. (1989 a, b, c); SBDA (1989b); Young and Kerr (1989); Argus and Pryer (1986); and J. Hudson (pers. comm.). It is also noteworthy that a number of comments and criticisms prepared by the SBDA (1989b) on the Rare Plant Section of the Draft IEE were not considered here because of a second independent review of both of the above documents by Harms (1989c).

The impacts of the Project on nationally rare plants would occur through four main mechanisms: 1) simple flooding and drowning out, 2) suppression of the occasional spring flooding of all or much of the valley bottom, 3) irrigation of benches and valley bottom flats which are not too saline or sandy, and 4) construction.

Simple flooding would perhaps eliminate much of the Goodwater population of witch grass. Harms (1989c) notes that, "Wilcox's Panic grass (called "Witch grass" in the federal report, Dicanthelium wilcoxianum), a both provincially and nationally rare grass species, was recorded from along lower Roughbark Creek at about the 1800′ contour line, where it appears likely threatened by inundation of the Rafferty Reservoir at the "full supply level" of 550.5 m (=1806.1′) and would be at the "maximum flood level" of 554 m (= 1821.6′), in contrast to the statements made on p. 34 in the SBDA Response". Due to lack of information on the rare plant communities of the valley, it is hard to say what other species would lose part of their populations, however tumble grass, whorled milkweed, and buffalo grass might also be affected. The Alameda Reservoir would also inundate colonies of side-oats grama grass, another species considered to be rare in Canada, as well as several species that are provincially rare (Harmes 1989c).

Reduction of spring flooding of the valley bottom downstream from the Rafferty Dam would adversely affect or eliminate other nationally and provincially rare plants by reducing the water supply for the flood plain forests. This could cause some or all of the trees to die, depending on local contributions of ground water. A reduction in flood frequency could affect the survival of the nationally rare heavy fruited sedge and the following provincially rare plants: silky milkweed, Assiniboia sedge, creeping lovegrass, wood nettle, western false gromwell, common Solomon's seal, American plum, black skull cap, blue vervain, nanny-berry, long-toothed Virginia creeper, and self-heal. This effect would be felt throughout the valley into Manitoba. Eliminating spring flooding would also lessen recharge of local small-scale valley bottom aquifers which in an undisturbed state would feed soil moisture back to the flood plain forest through the summer.

Reducing spring flooding could also affect populations of plants such as tumble grass, buffalo grass and whorled milkweed in Saskatchewan and Manitoba, which grow on clay flats and valley bottoms flooded just often enough that climax mixed prairie cannot survive there. White-flowered prairie parsley can occur on the upper edges of the flood-plain and thus may also be affected (Harmes 1989c).

Another long-term effect inimical to the survival of the rare plants of the Souris Valley is the proposal to establish irrigation projects downstream from both reservoirs. If irrigation development requires clearing of river-bottom floodplain forests or cultivating natural hay-lands in the river-bottom land the nationally rare plant white-flowered prairie parsley, which grows on benches or terraces could also be affected. Other rare plants that have been noted may not be greatly affected, such as the plants of sand and sandhills up out of the valley, such as western spiderwort, prostrate spurge, and Hall's bluestem; the plants of dry knolls and stony slopes, such as white milkwort, red three-awn; the cold spring species, small yellow monkey-flower; the ground water outcrop species small white lady's-slipper, (except as the springs and ground water outcrops or seepage areas are flooded) and the rock fern, smooth cliff-brake.

Harms (1989c) states that, "Three extremely rare species in Saskatchewan all occurring together at one site, and two at another nearby site, west of Estevan, appear very possibly threatened by proximity (within one-half mile) to the actual planned construction activities of the Rafferty Dam and associated projects such as the proposed diversion channel from Boundary Dam, the access road to Highway 18, and the relocation of the CPRR tracks. These plants are the locally sparse and provincially very rare clay flat species: Whorled Milkweed (*Asclepias verticillata*) also rare in Canada, Buffalo Grass (*Buchloe dactyloides*, also rare in Canada), and Whorled Milkwort (*Polygala verticillata*). These same species would also appear threatened by an alteration of ground-water table levels downstream from the dam. The recorded local colonies of the provincially rare grasses, Side-oats Grama (*Bouteloua curtipendula*, also rare in Canada) and Big Bluestem (*Andropogon gerardii*) at the Rafferty Dam construction vicinity would almost certainly be destroyed, but, unlike the latter three species, in their case there are fairly numerous other Souris Valley colonies".

Construction could also allow the introduction of pest species such as *Bromus inermis* (common brome), *Agropyron repens* (couch grass), *Sonchus arvensis* (perennial sow thistle), *Taraxacum* spp (dandelion), and (on dry ground) *Agropyron cristatum* (crested wheat grass). These species can colonize disturbed habitats and eliminate the native vegetation.

Species of slopes and warm sheltered valleys, such as prairie false dandelion, or of dry hot slopes, such as red three-awn, would not be expected to suffer. The tall-grass prairie species side oats grama grass and witch grass would be little affected by the Project. These species now, for the most part, occupy moist prairie habitats inside ravines of the valleys, moist because of the north-facing aspect or because the slope catches snow in winter. These habitats are merely relic's of a former widespread pre-agricultural distribution on low prairie outside the valleys to which they are now confined.

The major effects of the Alameda Dam on the remaining natural vegetation would be the long-term ones of: decreasing the water supply to floodplain-forests downstream on the Souris River; lessening the infrequent full valley floods downstream; and enabling irrigation of bottomlands and benchlands. Because of the narrowness and high gradient of the Moose Mountain Creek valley the reservoir would be relatively small and the short-term effects, would be restricted to a relatively small area.

10.4.6 Implications of Population Changes or Exterminations of Plant Species

Reduction of the numbers of a plant or other life-forms below some minimum value lessens its genetic diversity - that is, the total number of genes in the population - and so the species as a whole has less chance of producing individuals resistant to changing environmental conditions. Eventually such a species becomes extinct. A more physical effect of a population growing too small is that the flowers that do bloom have a poorer chance of being pollinated and hence of setting seed.

That a plant which is rare in Canada may possess a main range in the United States in which it is in no present danger of extinction has nothing to do with the issue or the responsibility to protect a diverse environment in Canada.

10.4.7 Mitigation

Mitigation for plants lost due to Reservoir filling, reduction of downstream flooding, and an altered groundwater regime is not possible. Impacts of channelization below Rafferty Dam could be reduced through construction practices and maintaining cut-off meander-loop habitat. Irrigation development impacts on rare plants would be reduced by establishing provincial reserves or parks in areas with significant rare plant populations.

10.4.8 Information Deficiencies

The relatively shallow valley of the Souris River above Estevan has been studied little by botanists because of lack of road accessibility - much of it is in community pastures. The Natural Vegetation chapter of the SBDA - EIS (1987a), describes a representative sampling of the natural vegetation of the upper Souris valley and compiled a floral list consisting of common and widely distributed species. The SBDA found no dominant vegetation types that they considered unique or rare. Rare species are not generally found in average representative habitats. They usually occur in micro-habitats. For instance, in the floral list (Appendix J) for the Rafferty and Alameda study area, no species are identified from ground water seepages, either calcareous or saline. In a landscape of till with 25 metres of relief, ground water seepage micro-habitats should be surveyed for rare plants. Similarly, if there are bare clay flats or clay flats only occasionally flooded, they should also be surveyed for species such as whorled milkweed, tumble grass, and perhaps even buffalo grass. Suitable habitats are present for these species, even though they are uncommon. These three species are examples from the national rare plant list.

Few data are available on the rare and unusual plant species of the upper Souris valley. Botanical surveys of the valley are required which examine unusual habitats.

If the project proceeds, botanical surveys at regular intervals in the down-valley region would be required to monitor the fate of floodplain plant communities. The results would be of value as baseline information. The SBDA (1989b) has proposed to monitor plant communities in the Souris River valley over the long term.

11 NAVIGABLE WATERS PROTECTION

The Navigable Waters Protection Act, (NWPA) administered by Transport Canada, requires that:

> **"No work shall be built or placed in, upon, over, under, through or across any navigable water unless**
> **(a) the work and site thereof have been approved by the Minister upon such terms and conditions as he deems fit prior to commencement of construction;**
> **(b) the construction of the work is commenced within six months and completed within three years of the approval referred to in paragraph (a) or within such period as the Minister may fix; and**
> **(c) the work is built, placed, and maintained in accordance with the plans, the regulations and the terms and conditions set out in the approval referred to in paragraph (a)."**

For the purposes of the Act, "work" includes, amongst other things, any bridge, dam, dumping of fill, excavation or any device or thing that may interfere with navigation. The Act does not fully define navigable waters, but precedent clearly shows that a stream the size of the Souris River would be considered navigable for purposes of the NWPA. For example, the use of a waterway by pleasure craft (e.g. canoe, small craft) would be sufficient to deem the waterway navigable.

In administering the NWPA, Transport Canada requires than an 'owner' submit an application outlining the nature of the proposed works. If it is determined that the work does not interfere substantially with navigation, then formal approval is not required and the department issues an exemption. If the work does interfere with navigation, the Minister will issue a licence with terms and conditions to protect navigation.

11.1 Existing Environment

While the Souris River at the Rafferty Dam site and Moose Mountain Creek at the Alameda Dam site could not be considered major waterways for the purpose of navigation, the NWPA is intended to protect the public right of access for any type of watercraft. Both dam sites are located on stretches of waterway that are navigable by smaller craft, such as a canoe.

11.2 Project Impacts

Both the Rafferty Dam on the Souris River and the Alameda Dam on Moose Mountain Creek would 'interfere substantially with navigation'. Under Section 5.1 of the NWPA, formal approval of the works is required to ensure that navigation rights are protected. Specific examples of potential hazards would include improperly marked spillways or intake structures. The NWPA grants powers to the Minister to regulate water flows and ensure that water elevations remain relatively stable with respect to waterways created through flooding and upstream or downstream works that may be affected by fluctuation of water levels (i.e. power and sewer lines). The Minister has the authority to order the owner to accommodate navigation by constructing marine craft canals at the site or marine launching facilities above and below the site.

11.3 Mitigation Measures

The province of Saskatchewan, Department of Environment and Public Safety, issued a Ministerial Approval under the Environmental Assessment Act, on February 15, 1988, for the Rafferty-Alameda project. The approval was subject to thirteen terms and conditions, of which condition 1.ii) states:

> **"The proponent shall comply with all pertinent Canada and Saskatchewan legislation and regulations as same may be amended related to the construction or operation of the development. Where such legislation and regulations impose more stringent standards than those imposed by the specifications, mitigative measures and environmental protection procedures described in the statement, the proponent shall comply with the more stringent requirements of the legislation and regulations."**

A federal licence for the Rafferty-Alameda project was issued on June 17, 1988 under the International River Improvements Act. The licence was revoked by the Federal Court on April 10, 1989, but one of the conditions in the licence was:

> **"The licensee shall comply with the provisions of all federal statutes that relate to the improvement and with the relevant provisions of any regulation made pursuant to such statutes. In addition, the Licensee shall comply with the specific terms and conditions which apply to the improvement contained in the provincial Ministerial Approval under the Environmental Assessment Act of the province of Saskatchewan, dated February 15, 1988."**

Both the provincial environment approval and the federal IRIA approval state clearly that the Proponent shall comply with all federal legislation or regulations related to the Project.

An exchange of correspondence between Saskatchewan Water Corporation and Transport Canada in April 1988 confirmed that, as an agent of the Crown, the Corporation was not bound by the Act. Suggestions to seek approval of the Minister of Transport for the works, with respect to navigation rights, were not followed up by the Corporation. To date, the province has made no further efforts to seek approval under the NWPA.

The opportunity exists for mitigating the potential impact of this Project on navigation. Prior to the Minister of the Environment issuing a licence under the International River Improvements Act, the Project Proponent could be required to meet the requirements of the Navigable Waters Protection Act.

12 SUMMARY

12.1 General

This IEE provides information for public scrutiny on the nature, extent, and significance of the Rafferty-Alameda Project's environmental impacts on areas of federal responsibility. It also examines the efficacy of known mitigation measures proposed to address these impacts and identifies information deficiencies. The information documented in this report will be compiled with the public response to provide the Minister of the Environment with guidance in making a decision on licensing the Project under the International River Improvements Act (IRIA).

The proposed Project requires a licence under the IRIA. The Act ensures that the long-term national interest is safeguarded in water resource developments involving international rivers. As Minister responsible, the Minister of the Environment will consider the following in reaching a decision on the licence:

- the protection and enhancement of Canadian interest, both in Saskatchewan and Manitoba,
- environmental and social impacts of the Project on areas of federal responsibility, and
- the maintenance of international obligations to the United States under the Boundary Waters Treaty.

Section 8 of the Environmental Assessment and Review Process (EARP) Guidelines Order states that where an agency of the Government of Canada has a regulatory function in respect of a proposal, the Guidelines Order shall apply. Section 3 of the Order explains that this is to ensure that the environmental implications of all proposals for which it is the decision making authority are fully considered.

The conclusions of the IEE refer to the environmental implications of the Project in areas of federal responsibility related to the IRIA licence. The IEE does not address environmental issues that are of concern solely to the provinces or to the United States.

For each area of federal responsibility, including water quantity, water quality, migratory birds, fisheries, federal lands, rare and endangered species, and navigation, the following are addressed:

- project impacts,
- mitigation,
- residual impacts,
- information deficiencies that must be addressed before a decision on the Project and be made, and
- long-term information deficiencies.

12.2 Overview of Environmental Impacts, Mitigation, and Information Deficiencies

This section identifies project impacts, mitigation opportunities, and information deficiencies related to areas of federal jurisdiction and interest. Table 12.1 has been prepared to identify specifically those project impacts of high and moderate significance that are of concern to the federal government. Table 12.2 provides a list of associated information deficiencies that must be addressed prior to further consideration of Project licensing under the IRIA by Environment Canada.

The tables provide an overview of key federal concerns. The remaining sections of this chapter supplement that overview information with more detail and information about impacts that are of lower priority or less concern.

The assessment was carried out from the perspective that the primary function of the Project was to alter the hydrologic regime of the Souris River basin to realize specific benefits, such as improved water supply and flood control. Environmental impacts to water quality, migratory birds, fisheries and others will result from that alteration. The impacts listed in Tables 12.1 thus do not address water quantity per se, but rather focus on the impacts to basin resources that result from changes in the quantity of water available. Some of the information deficiencies identified in Table 12.2 are related however to water quantity and are key to understanding the environmental implications of the Project.

Table 12.1 Summary of Adverse Environmental Impacts Caused by Altered Flows and Lake Levels

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SIGNIFICANT IMPACTS

* **Reduced Downstream Flows:** Flow reductions during years of normally low flow would aggravate an already poor water quality situation in the Souris River in Manitoba. The recreational value of the river would be diminished because of earlier and longer periods of instream biological growth, longer periods of reduced dissolved oxygen, and increased incidence of high free ammonia concentrations. Mitigation options should include flow augmentation alternatives involving modified operational plans and structural considerations in North Dakota, Saskatchewan and Manitoba.

* **Waterfowl Productivity:** Within Saskatchewan and North Dakota the Project would have significant adverse effects on waterfowl production. Complete mitigation of waterfowl impacts is feasible; and mitigation and monitoring plans must be developed for North Dakota and Saskatchewan before the Project proceeds.

- **Lake Darling Fishery**: The flows entering North Dakota would be reduced by 44 percent and would have associated water quality effects, would result in a decline and possible elimination of the fish population in Lake Darling. Mitigation options are limited.

- **Fish Habitat**: The Project would result in losses of riverine habitat in Saskatchewan. These losses would be fully mitigated through replacement with reservoir habitat. The Project should achieve "no net loss" of productive habitat in Saskatchewan. In Manitoba the Project would result in the loss or alternation of productive fish habitat. Compensation for this loss or alteration, would be required.

- **Federal Lands:** Approximately 1700 ha of federal community pasture lands would be lost to the reservoirs. Full mitigation of the impacts would be achieved through the replacement of pasture lands with lands of equal carrying capacity.

- **Rare and Endangered Species (Plants and Animals):** The Project would have significant adverse effects on the ferruginous hawk (**THREATENED**) and possibly seven plant species of national significance through inundation by the Reservoirs or altered downstream flows through to Manitoba. Opportunities for mitigation would be limited. Over the long term, information on the distribution and abundance of rare plant species in the floodplain is required for Saskatchewan and Manitoba.

- **Navigable Waters**: Both Rafferty and Alameda reservoirs would impact on navigation. Impacts and concerns for public safety can be mitigated through design and construction considerations, and proper marking of hazards to navigation.

MODERATE IMPACTS

- **International Water Quality:** Reservoir releases would intermittently impact on downstream water quality (free ammonia, dissolved oxygen and dissolved salts). International water quality objectives for both boundaries would be required to determine the acceptability of Project-induced water quality impacts. Mitigation could be accomplished through multilevel outlets and coordinated reservoir releases.

- **Mercury in Fish:** Mercury levels in fish tissue would increase in the reservoirs and possibly downstream. Mitigation options are not well understood. Monitoring and the development of consumption advisories are required in order to protect the public.

- **Baird's Sparrow**: Inundation of the Souris River valley by Rafferty Reservoir would reduce critical habitat and local populations of this **THREATENED** species. Further studies are required to confirm the extent of the loss.

Table 12.2 Summary of Information Deficiencies

SIGNIFICANT DEFICIENCIES

- The basic data for Saskatchewan from 1974 to 1981 should be reviewed. The hydrology data in Saskatchewan, Manitoba and North Dakota should be updated to 1988, including data on existing and proposed water uses. These data are not required to assess the overall impact of the Project, but are critical for development of operating plans.

- Operating criteria used in the hydrologic model have been evolving continually since the preparation of the SBDA's EIS. A water management plan should be developed which would include Saskatchewan's operation of the Project, the operation of the national wildlife refuges in North Dakota, and account for Manitoba's entitlement.

- International water quality objectives against which impacts on transboundary water quality can be assessed do not exist. If the Project proceeds, formulation of international water quality objectives should be undertaken immediately for those parameters which are considered most likely to be affected.

- The EISs from the SBDA and the U.S. Army Corps of Engineers do not consider the collective impacts of the Project and the U.S. Souris River Basin Project on the quality of the Souris River at the North Dakota - Manitoba boundary.

- The operation of the national wildlife refuges in North Dakota effect the water quality at the North Dakota-Manitoba boundary. A precise operating plan is required to assess the water quality implications and opportunities for mitigation.

- Comprehensive mitigation and monitoring plans for waterfowl production would be required before a decision could be made on whether the Project should proceed.

- Insufficient information exists on fish habitat in the Souris River in Manitoba. As well, the significance of Lake Darling and its fish populations to the downstream reaches of the Souris River in Manitoba is unknown. Such information is required in order to accurately predict impacts of the Project on fish and to determine suitable compensation options in order to achieve "no net loss" of productive fish habitat.

- Information and data are lacking for comparative evaluations of habitat quality in the flooded area in terms of nesting and foraging value and the surrounding range for the ferruginous hawk.

- The distribution and abundance of rare plant species in the Souris River floodplain in Saskatchewan and Manitoba needs to be studied in more detail. Particular emphasis should be placed on the reach to be inundated by the Rafferty Reservoir.

MODERATE DEFICIENCIES

- Spring flood-flow rejuvenation of the Souris River and downstream of the Project would be reduced, relative to existing conditions. It is not known how the effects of this would be manifested in the aquatic ecosystem.

- The water quality models used by the Proponent have not been fully field tested, calibrated or verified within the Souris River basin, although some testing was undertaken in 1989. This deficiency places some doubt upon the results.

- Data should be collected on the distribution of riparian and upland waterfowl habitat types, and on the size and composition of the resident breeding waterfowl population, along the Souris River in Manitoba. These data are required in order to substantiate the expectation that the Project would not adversely affect waterfowl production along the Souris in Manitoba.

- Quantitative baseline information is lacking on the status of Baird's sparrow in the Souris valley, particularly in the vicinity of the Rafferty and Alameda Dam sites.

12.3 Water Quantity

12.3.1 Project Impacts

Saskatchewan

1. Saskatchewan would be able to store and use a larger share of the water of the Souris River as allowed under the 1959 Interim Measures administered by the International Joint Commission. Storage of flood flows has been negotiated with the United States in return for credit of an evaporation allowance for the reservoirs. During flood years, Saskatchewan would, therefore be able to retain up to 60 percent of the natural flow of the Souris River. Saskatchewan would be able to store up to 50 percent of the natural flow of the Souris River during normal or low flow years.

2. Storage of flood waters by the Project would make water available for Saskatchewan use during wetter years.

3. Spring flooding would be reduced on the Souris River and Moose Mountain Creek downstream of the Project.
4. Flooding within reservoir areas would inundate farmland, fish and wildlife habitat and floodplain plant communities.
5. In general, summer flows downstream of the Project on the Souris River and Moose Mountain Creek would be greater than those experienced in the past.
6. Some unseasonably high flows would occur prior to and after flood events as stored water is released. No overbank flooding would occur unless caused by ice jams. Winter release of water could result in extensive ice build-up if not done properly.
7. Some erosion could be experienced during high flows downstream of the Rafferty Dam due to the changed stream gradient.

North Dakota

1. Storage of flood flows by the Project would reduce the flood hazard in North Dakota, especially at Minot.
2. The Project would reduce the total amount of water reaching North Dakota, and so would affect all water users. A reduced supply of water may be available to water users.
3. The operation of Lake Darling and the refuges on the Souris River in North Dakota would be adversely affected by the reduction in flow. North Dakota would have a limited water management benefit through coordinated use of the reservoirs.

Manitoba

1. As a result of the Project, the amount of water reaching Manitoba would be reduced.
2. Generally, flood damages in Manitoba would be reduced, however, certain urban and agricultural locations may receive more flood damage in some years because of pre-flood releases or extended duration of flow after major floods.

12.3.2 Mitigation of Project Impacts

Saskatchewan

1. Accurate flow forecasts are required to optimize water management prior to flood events, and to allow water users to plan their activities during both the high and low flow years.

North Dakota

1. Operations of the reservoirs within the United States should adopt a suitable operation plan to optimize use of water.

Manitoba

1. Flood damages in Manitoba caused by the Project should be mitigated.
2. A flood forecasting system is required for Manitoba to minimize urban and agricultural impacts caused by changed streamflow patterns.
3. Careful water management is required to minimize the number of times that severe drought criteria would be implemented.

International

1. A comprehensive water management plan for joint Saskatchewan-North Dakota-Manitoba operation of the Project is desirable. Regular updates of this plan should be made. Accurate flood forecasting is needed to optimize benefits and improve operations.

12.3.3 Residual Impacts

International

1. The reduction of flow to North Dakota, and hence Manitoba, cannot be avoided if the Saskatchewan reservoirs are constructed. The Project, however, can be operated within the scope and intent of the 1959 Interim Measures.

12.3.4 Information Deficiencies

International - Immediate

1. Operating criteria used in the hydrologic model have been evolving continually since the preparation of the SBDA's EIS. A water management plan should be developed which would include Saskatchewan operations of the Project and the operation of the national wildlife refuges in North Dakota in conjunction with Manitoba's requirements.
2. The basic hydrology data for Saskatchewan from 1974 to 1981 should be reviewed. The data in Saskatchewan, Manitoba, and North Dakota should be updated to 1988, including data on existing and proposed water uses. These data are not required to assess the overall impact of the project, but are critical for development of a water management plan.

12.4 Water Quality

12.4.1 Project Impacts

Saskatchewan

1. The Project would generally benefit periods of normally low flow in the Souris River. Relative to the existing poor quality which is associated with low flow, these enhancements would generally result in improving instream concentrations of dissolved oxygen, free ammonia, and aesthetic characteristics.

2. Nutrient upsurge during the first filling period, coupled with warm temperatures, would create ideal conditions for nuisance organisms in Rafferty Reservoir. This stored water would be of international concern if it is released undiluted. For filling periods in excess of approximately ten years, concentrations of TDS, boron, sodium, and sulphate are expected to increase steadily.
3. Rafferty Reservoir releases which occur during periods of summer anoxia would affect aquatic life possibly for tens of kilometres downstream because of high free ammonia and low dissolved oxygen. The deteriorated condition would rarely extend into North Dakota.

4. Project regulation of flows would reduce the magnitude of the extremes for many water quality constituents. A relatively more stable instream aquatic biological community in the Souris River between the reservoirs and Lake Darling may result.

5. Mercury concentrations in fish tissue would increase before reaching a stable condition. Concentrations would increase for approximately 10 years before showing signs of stabilizing. Significant elevated levels of mercury in fish of Lake Darling would not be expected.

6. A gradual increasing trend in Rafferty Reservoir TDS concentrations over a period of several decades, is inevitable and would have international implications during rare events when Rafferty releases constitute a significant proportion of the transboundary flow. The same is true for the trophic status of Rafferty Reservoir.

7. A flood of 1:100 or greater would replenish all reservoirs in the basin with high quality water (TDS<300 mg/L). This improved quality water would be maintained within the reservoirs and the mainstem Souris River for several years following this event.

North Dakota

1. The quality at the Saskatchewan-North Dakota boundary may be improved or impaired depending on the storage situation in the upstream reservoirs, spring runoff and the quality of source water. If moderate to wet years prevail, there should be water quality improvements realized

throughout the basin during the low flow months of June to March.

2. Spring water quality at the international boundary may be impaired slightly relative to existing water quality because of the flow reduction but still within North Dakota water quality standards. Water quality during the remainder of the year would be better than existing conditions with fewer exceedances of the standards for TDS, sulphate, chloride and boron.

3. The reduced flows from Saskatchewan and the trapping efficiency of the reservoirs and weirs would benefit Lake Darling by reducing sediment, nutrient loading, and other associated substances.

4. Eutrophication of Lake Darling is a natural long term aging process and can only be retarded not prevented. Lower lake levels and reduced spring flushing may accelerate the process even though nutrient loading and sedimentation from Canada is reduced.

5. There would be more frequent exceedances of the North Dakota water quality standards for TDS, chloride, sulphate, boron, dissolved oxygen and free ammonia if Rafferty Reservoir releases constitute the major proportion of water at the International Boundary.

6. As a result of reduced water volumes in Lake Darling, dissolved solids are expected to increase gradually until such time as a major flood within the basin sets the TDS in all reservoirs back to lower concentrations.

7. Changes in water quality at the Saskatchewan-North Dakota boundary, and which are attributable to the Project, would not be measurable at the North Dakota-Manitoba boundary because of the 660 km river reach through which the river flows. However, changes in the operation of Lake Darling resulting from reduced flows from Saskatchewan, would itself induce water quality changes downstream.

8. A modified flow regime would impact Lake Darling and to a less extent the river. It would be more difficult for the U.S. Fish and Wildlife Service to maintain a viable sports fishery on Lake Darling because of a greater frequency of summer and winter fishkills associated generally with low dissolved oxygen and lower lake levels.

9. The assimilative capacity of the Souris River below city of Minot municipal treated effluent would be reduced during periods of low flows. As a result, the quality of water entering J. Clark Salyer National Wildlife Refuge can be expected to deteriorate during low flow periods exacerbating the potential for outbreaks of botulism in waterfowl.

Manitoba

1. Water quality under June to October low flow conditions may be affected because North Dakota may deliver to the international boundary only sufficient water to meet the requirements of the Interim Measures (0.566 m^3/s). The frequency and duration of this minimum flow requirement would increase in the future, and could result in higher concentrations of free ammonia and biologically available dissolved nutrients.

2. In wet years, extended releases from J. Clark Salyer National Wildlife Refuge into the summer should have a net positive effect on the quality of water in Manitoba.

3. Waste-water assimilation in the Souris River in Manitoba would be affected with more frequent periods of low flow. On the other hand, there would be the benefit of drawing down lagoons over a longer period of time in the spring of wet years when the higher than natural flows extend into summer.

4. Augmentation of monthly flows over historical would have occurred in less than 4 percent of the years whereas decreases would have occurred in 17 percent of the years, had the Project been in place in the period 1912 to 1974. If water quality in the Souris River in Manitoba is directly related to the amount of water received from Manitoba, then the quality of water should remain unchanged from existing conditions most of the years.

12.4.2 Mitigation of Project Impacts

The mitigation requirements described below would ameliorate most of the water quality impairments identified in this evaluation. Those areas where further information is required before final judgments can be made concerning mitigation, are included in Section 6.6 under information deficiencies. Some unmitigable impacts have been identified in Section 6.5. The following mitigation requirement are presented in no particular order.

Saskatchewan

1. Due to the uncertainties associated with the water quality predictions related to the reservoirs and downstream areas, Canada, in cooperation with the Proponent and affected jurisdictions, should develop a comprehensive aquatic ecosystem monitoring plan which would monitor Project impacts, trends and compliance with transboundary standards or objectives.

2. A multilevel outlet for both Rafferty and Alameda Reservoirs would facilitate water quality management choices for controlling and maintaining acceptable water quality in transboundary waters, particularly as related to anoxic conditions.

3. The operational plan for the Canadian reservoirs must allow for flow adjustments (e.g. use Alameda to dilute Rafferty releases) in complying with transboundary water quality requirements.

4. Riffle areas and irrigation impoundments (weirs) would enhance instream recovery from anoxic water quality conditions so that these conditions do not become a transboundary issue. Opportunities to achieve water quality benefits from these weirs and from artificial riffle areas should be considered by the Proponent.

5. Sound water management practices on and contiguous to the reservoirs would serve to protect reservoir water quality and therefore, provide an added degree of protection to transboundary water quality. Consideration could include land use controls, water use controls, reservoir use capacity studies, boat restrictions, etc.

6. A coordinated water quality monitoring plan is required to ensure that data are being collected, and interpreted appropriately and that water quality management decisions are made consistent with meeting Canada's obligations under the Boundary Waters Treaty.

7. Upsurge of nutrients, metals and salts in newly created reservoirs can be partially controlled (minimized) through proper preparation of a reservoir base (clearing).

8. Rafferty Reservoir water quality objectives should be established for TDS and selected constituents to trigger implementation of water quality management options and early warning for North Dakota and Manitoba.

9. Canada, in cooperation with the Proponent and affected jurisdictions should establish transboundary water quality objectives (Saskatchewan and Manitoba boundaries) through international negotiations prior to project approval, to serve as guidelines in the management of upstream water. Objectives should be established for only those constituents which are predicted to be altered.

10. Channelization below Rafferty should include a plan to appropriately dispose of dredged materials so that they do not impact on transboundary water quality.

North Dakota

1. Both United States and Canadian authorities (Federal and Provincial) should monitor on an ongoing basis the level of mercury in fish and produce consumption advisories or guidelines to protect the public, as required.

2. A modified operation plan for J. Clark Salyer National Wildlife Refuge may minimize adverse affects.

3. The U.S. Army Corps of Engineers has noted that the city of Minot may have to further upgrade its sewage treatment if the dilution capacity of the Souris River is reduced to the extent that the lower refuge and Manitoba are adversely affected by more concentrated sewage.

4. Instream aquatic uses could be maintained by providing a minimum flow to Manitoba.

5. Transboundary water quality objectives should be established through international negotiations to serve as guidelines in the management of upstream water. Objectives should be established for only those constituents which are influenced by upstream activities.

Manitoba

1. The four municipalities of Melita, Hartney, Coulter and Souris all discharge sewage effluent into the Souris River. To maintain adequate Souris River water quality, the timing of releases may require change as may the capacity of lagoons to hold larger volumes of waste through extended drought periods. Upgrading of treatment facilities may also be an alternative.

2. Canada, in cooperation with the jurisdictions concerned should develop a aquatic ecosystem monitoring plan for the Souris River basin. As part of this plan, an international committee should be established to oversee monitoring throughout the basin and to monitor compliance with water quality objectives.

12.4.3 Residual Impacts

1. A gradual increasing trend in Rafferty Reservoir TDS concentrations over a period of several decades, is inevitable and would have international implications during rare events when Rafferty releases constitute a significant proportion of the transboundary flow. The same is true for the trophic status of Rafferty Reservoir.

2. Eutrophication of Lake Darling is a natural long term aging process and can only be retarded not prevented. Lower lake levels and reduced spring flushing may accelerate the process even though nutrient loading and sedimentation from Canada is reduced. This would be expected to be of low to moderate significance.

3. A modified flow regime would impact Lake Darling and to a less extent the river. It would be more difficult for the U.S. Fish and Wildlife Service to maintain a viable sports fishery on Lake Darling because of a greater frequency of summer and winter fishkills associated generally with low dissolved oxygen and lower lake levels. This is a highly significant impact of the Project.

4. Water quality under June to October low flow conditions may be affected because North Dakota may deliver to the international boundary only sufficient water to meet the requirements of the Interim Measures (0.566 m^3/s). The frequency and duration of this minimum flow requirement would increase in the future, and could result in higher concentrations of free ammonia and biologically available dissolved nutrients. Should increased declarations of drought occur, the impact would be of moderate significance.

5. In moderate to wet years, there would be prolonged releases from J. Clark Salyer National Wildlife Refuge extending into the early to mid summer. Although this would increase the summer flushing of nutrients into Manitoba, the net effect on overall water quality and aesthetics should be positive.

12.4.4 Information Deficiencies

1. International water quality objectives against which impacts on transboundary water quality can be assessed do not exist. The assessment has had to rely on provincial objectives, Canadian water quality guidelines and North Dakota water quality standards. In many instances, these 'indicators' of water quality differ. If the Project proceeds, formulation of international water quality objectives should be undertaken immediately for those parameters which are considered most likely to be impacted: dissolved oxygen, ammonia, total dissolved solids, sulphates, chlorides and boron.

2. The data base (1972-76) for Moose Mountain Creek adequately describes its quality for a series of wet years. Characterization of conditions during a dry cycle is required to improve the level of confidence associated with Alameda predictions. This is a minor deficiency that should be addressed by the proponent over the long term.

3. Spring flood-flow rejuvenation of the Souris River and downstream of the project would be reduced, relative to existing conditions. It is not known how the effects of this would be manifested in the aquatic ecosystem.

4. The EISs from the SBDA and the U.S. Army Corps of Engineers do not consider the collective impacts of the Project and the U.S. Souris River Basin Project and the operating plan of the NWRs on the quality of the Souris River at the North Dakota-Manitoba boundary. This is a major deficiency which must be addressed before the Project proceeds.

5. The water quality models applied by the proponent should be calibrated and verified with field data from the Souris River Basin. A key focus must be placed on free ammonia concentrations during critical flow periods, and the impact on indigenous aquatic organisms. This is a minor deficiency and can be addressed either before or after Project completion.

6. Uncertainty still exists as to the precise operational plans associated with the National Wildlife Refuges in North Dakota (under project conditions). Given that either increased high or low flow conditions can affect water quality in Manitoba, the final plans should be provided to all agencies concerned for their evaluation. This plan should be made available to Manitoba and Canada before the Project proceeds.

7. Research should be conducted into understanding the effect of flow on the summer biological productivity of the river, identifying flow criteria to minimize *Cladophora* blooms and incidences of high free ammonia. This information is required over the long term and could be addressed through multi-party participation.

8. Irrigation development in Saskatchewan and the effects on water quality have been dealt with superficially. Water quality predictions have been based upon many assumptions without strong substantiation. Environment Canada agrees that irrigation return flows should not be a major concern given the size of the proposed development (4055 ha) and the likely small volume of return flow. Given that full development of irrigation would take many years, there is ample time for the Proponent to provide more definitive information on expected water quality impacts. This is a minor information deficiency.

12.5 Migratory Birds

12.5.1 Project Impacts

Considering both direct impact in Saskatchewan and indirect impacts in North Dakota, losses to Canada could amount to 8700 ducks each year. This loss represents 18 percent of the number of breeding mallards expected to be produced annually from the Moose Mountain Uplands key program area through the **Saskatchewan Implementation Plan** of the **NAWMP**. The total loss in Canada and the United States is, therefore, substantial and would seriously jeopardize the success of the **NAWMP** in the prairie pothole region of Canada and the United States, unless complete mitigation occurred.

Saskatchewan

1. Losses of waterfowl production in Saskatchewan, resulting from inundation of river valley habitat by the Rafferty and Alameda reservoirs and channelization below Rafferty Dam, could amount to approximately 4300 ducks annually.

2. Off-river drainage into project works, and increased waterfowl harvest in the vicinity of the reservoirs would increase this loss significantly, if permitted to occur.

3. A portion of the direct loss of waterfowl in Saskatchewan would also represent an indirect loss to the United States through the international breeding reservoir.

North Dakota

1. Modified flow regimes in North Dakota are expected to significantly affect wetland habitat and management of the Upper Souris and J. Clark Salyer national wildlife refuges. Significant reductions in waterfowl production from the two refuges are expected to be in the order of 21 800 ducks annually, not including increased mortality due to avian botulism. Reduced hunting opportunities are also expected as a result of waterfowl short-stopping at the Rafferty and Alameda reservoirs.

2. Annual indirect losses to Canada, associated with the loss in North Dakota, could amount to approximately 4400 ducks.

Manitoba

1. Significant reductions in waterfowl production along the Souris River in Manitoba are not expected to occur as a result of the Project. However, further information is required to substantiate this expectation.

12.5.2 Mitigation of Project Impacts

International

1. Because of the Canada and United States initiative to restore continental duck populations through the **NAWMP**, all waterfowl production losses associated with the Project in Saskatchewan and North Dakota would have to be completely mitigated.

2. Waterfowl losses would have to be compensated for on the basis of in-kind/acre-for-acre replacement of habitat.

3. While complete mitigation is theoretically possible, its achievement is tied to the commitment of appropriate agencies in putting into place effective mitigation programs.

4. Waterfowl production from the reservoirs and mitigation lands, the control of drainage of off-river wetlands into Project works, and restricted waterfowl harvest in the vicinity of the two reservoirs, would require intensive monitoring.

12.5.3 Residual Impacts

None, provided that all waterfowl production losses were mitigated.

12.5.4 Information Deficiencies

1. Comprehensive mitigation and monitoring plans for waterfowl production would be required before a decision on whether the Project can proceed is made. These plans would consist of:

a. a description of the land parcels to be secured for mitigation purposes;
b. a description of the habitat management techniques which would be employed in order to convert each land parcel into productive waterfowl habitat;
c. an account of the waterfowl production expected from the mitigation lands in relation to the predicted waterfowl production losses; and
d. a description of the population monitoring studies which would be conducted in order to determine the degree to which complete mitigation was achieved;
e. a description of the land use monitoring program that would be implemented in order to confirm that further drainage of off-river wetlands was not occurring; and
f. a description of the restrictions that would be placed on waterfowl harvest from areas adjacent to the reservoirs, and the compliance monitoring program that would be implemented, in order to ensure that increased harvest levels were not occurring.

2. Data should be collected on the distribution of riparian and upland waterfowl habitat types, and on the size and composition of the resident breeding waterfowl population, along the Souris River in Manitoba. These data are required in order to substantiate the expectation that the Project would not adversely affect waterfowl production along the Souris in Manitoba.

12.6 Fish and Fish Habitat

Under the federal Fish Habitat Management Policy the governments of Canada, Saskatchewan and Manitoba would strive to balance unavoidable habitat losses with habitat replacement, on a project-by-project basis so that further reduction to Canada's fisheries resources due to habitat loss or damage may be prevented. The long-term policy objective is the achievement of an overall "net gain" of the productive capacity of fish habitats. Progress towards this objective can be achieved through the active conservation of the current productive capacity of habitats (no net loss), the restoration of damaged fish habitat and the development of new habitats.

12.6.1 Project Impacts

Saskatchewan

1. Losses of riverine and gains of reservoir fish habitats are anticipated from the Project.

2. Mercury levels in fish tissue are anticipated to increase in the proposed reservoirs and downstream.

North Dakota

1. The combined effect of construction, trophic upsurge, lower flows, hypolimnetic releases and increased irrigation return flows would probably increase the risk of winterkill in Lake Darling and the J. Clark Salyer NWR. If Saskatchewan retains 50 percent of the annual flow and proceeds with planned flood operations, there would be a decline arising from diminished annual flows and water quality changes, and possible elimination of the fishery values of Lake Darling and of the Souris River proper. This recreational fishery is valued at approximately $4,000,000 per year to the local economy in North Dakota. Outside of the Missouri and Red River systems, the Souris River system is the most heavily utilized river fishery in North Dakota.

2. The project could increase the risk of carp invasion to North Dakota.

Manitoba

1. The Project would result in the loss or harmful alternation of productive fish habitat in Manitoba. Lower than historical flows, changes in flow regime and altered water quality, as a result of the Project may compromise an estimated $70,000 per year recreational fishery.

12.6.2 Mitigation of Project Impacts

Saskatchewan

1. Opportunities exist to achieve a "net gain" in productive fish habitat. Reservoir fisheries can be dramatically improved by manipulating water levels and by construction of artificial habitats.

2. Construction of fishways would reduce fish losses by facilitating migration over dams and weirs.

3. Fish screens would prevent entrainment and entrapment of fish during water transfer operations.

4. "Natural" stream geometry can be simulated in rehabilitation schemes that enhance or create physical stream characteristics in uniform drainage canals.

5. Removal of sod and upper soil layers in reservoirs may assist to mitigate the elevation of mercury levels in fish tissue which is anticipated to increase in the proposed reservoirs and downstream.

North Dakota

1. Available options to salvage the fishery at Lake Darling would be limited.

Manitoba

1. "No net loss" of fish habitat in Manitoba may be achieved. In part, this may require the continuation of the present apportionment flow regime (May to October), no increase in the declaration of severe drought conditions pursuant to the 1959 Interim Measures, and no deterioration of winter survival conditions for fish.

2. Compensation for any loss or harmful alteration of fish habitat due to lowered annual flows, changes in flow regimes including reduced flood peaks, and altered water quality would be required.

12.6.3 Residual Impacts

Saskatchewan

1. Low flows downstream of the proposed dams are expected to produce residual impacts on fish resources, however, these impacts would be compensated for through the creation of fish habitat in the Reservoirs.

North Dakota

1. The Saskatchewan Reservoirs would have significant impact upon fish and fish habitat.

Manitoba

1. During flood operations, flood peaks in Manitoba would be lower and of longer duration. This could be expected to negatively impact northern pike and yellow perch spawning success and populations of these species could decline.

2. Lowered annual volumes of water and altered water quality would lead to an overall decline in fishery values if lost and degraded fish habitat is not adequately compensated for.

12.6.4 Information Deficiencies

1. Insufficient information exists on fish habitat in the Souris River in Manitoba. As well, the significance of Lake Darling and its fish populations to downstream reaches of the Souris River in Manitoba is unknown. Such information is required in order to accurately predict impacts of the Project on fish and to determine suitable compensation options in order to achieve "no net loss" of productive fish habitat. If the Project proceeds the Proponent should evaluate fish abundance and habitat before the dam is operational.

12.7 Federal Lands

12.7.1 Project Impacts

Saskatchewan

The Project would have an impact on federal lands. These federal lands, community pastures Estevan-Cambria and Lomond #1, are administered by Agriculture Canada, Prairie Farm Rehabilitation Administration. The impact would be in the form of loss of pasture land (1690 ha) resulting in a loss of carrying capacity for cattle. In addition, there would be loss of direct access by some patrons to the pastures.

12.7.2 Mitigation of Project Impacts

Saskatchewan

The Project was approved, under the authority of the Saskatchewan Environmental Assessment Act by a Ministerial Approval which contains a condition requiring that these impacts on federal lands be mitigated. The project proponent, the Souris Basin Development Authority has developed a mitigation plan for the pastures. PFRA has approved in principle the mitigation plan for the Estevan-Cambria Pasture and the SBDA is actively assembling replacement lands for lands to be lost in Lomond #1 Pasture. PFRA, on behalf of Agriculture Canada, has concluded that the impacts of the project on the two pastures would be fully mitigated.

12.7.3 Residual Impacts

None.

12.7.4 Information Deficiencies

None.

12.8 Rare and Endangered Species

12.8.1 Rare and Endangered Fauna

Eleven species listed as either endangered or threatened under COSEWIC designations may be influenced by project construction and, to a lesser extent, project operation. Most species would only be affected marginally, although at least two species, the burrowing owl and ferruginous hawk populations, may be impacted as a consequence of reservoir siting and flooding of nesting habitat. Piping plover could, potentially, with appropriate measures, benefit from reservoir construction.

12.8.1.1 Project Impacts

Saskatchewan

1. The ferruginous hawk population would tend to lose considerable foraging opportunities following the flooding of agricultural land. In addition the ferruginous hawk would lose nesting habitat and possibly existing nesting sites. These losses would not significantly affect Canadian populations of these birds.

2. Baird's sparrow, recently added to the COSEWIC list as "threatened" has considerable potential for habitat loss within the Project area. The implications to the extent of the population are unclear without additional comparative studies of habitat availability and quality in the flooded area with that in surrounding grasslands.

3. The piping plover may benefit from reservoir construction provided that suitable shore-line habitat is created and protected for nesting use.

4. Seasonal migrants, such as the whooping crane would not be significantly affected. In the long term, these species might benefit from the development of additional shoreline habitat for feeding and resting during migration provided that recreational and other uses do not inhibit their use.

5. The eastern bluebird nests in the valley areas downstream of both reservoirs but its resilience to temporary disturbance would result in minimal impact to this species.

6. The only mammal of concern, the prairie long-tailed weasel, is widely distributed in southern Saskatchewan and is not considered threatened in this part of its range. Since exact distribution information is lacking, the impacts of reservoir construction are unclear. However, they would likely be insignificant from a total population standpoint, considering the weasel's habitat preferences for ecotones close to free standing water.

North Dakota

1. The U.S. Army Corps of Engineers identified four federal (U.S.) listed endangered species which may be present in the North Dakota portion of the Project area. They state that the area contains no critical habitat for either the bald eagle or the peregrine falcon and therefore impacts would be negligible on either of these species (U.S. Army Corps of Engineers EIS, 1988).

2. Further conclusions drawn from studies conducted for or by the U.S. Army Corps of Engineers suggested that, although, the proposed evaporation sharing agreements would alter resources used by threatened and endangered species, these alterations would not be significant enough

to negate their use by those species.

3. Both the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service concurred that the Lake Darling, one foot raise, project would not have an adverse effect on protected species or their critical habitat.

4. According to the U.S. Army Corps of Engineers EIS, the Souris River basin plan would reduce the potential for construction related impacts on protected species and their habitat below the already negligible effects anticipated for the Lake Darling project.

5. Operation of the Souris River Basin plan is not anticipated to impact protected species since neither critical habitat nor special use by protected species was identified (U.S. Army Corps of Engineers, EIS, 1988).

Manitoba

1. Flooding in the restricted 10 km reach downstream of the international border in Manitoba would exhibit lower flood peaks but would be of longer duration. Some direct impacts due to losses in nesting sites and habitat may accrue to raptors in the vicinity but would likely be negligible. This requires further substantiation with field survey data.

12.8.1.2 Mitigation of Project Impacts

Saskatchewan

1. Mitigation of losses of ferruginous hawk nesting sites and nesting habitat can be accomplished through the provision of alternate sites and habitat, particularly the development of artificial nest sites. This has already been proposed by SBDA for the grasslands surrounding the reservoir.

2. Enhancement of piping plover nesting habitat along the reservoir shoreline is also possible with man made beaches of suitable material for nesting.

3. Mitigation and perhaps even enhancement could be achieved for the eastern bluebird population with a more precise survey of their nesting habitat and provision of artificial nesting boxes in suitable locations.

4. Mitigation for other threatened and endangered species would not be required.

North Dakota

1. No critical habitat was identified within the U.S. portion of the Project area nor significant impacts on resources used by threatened and endangered species. Impacts were therefore considered negligible and mitigation not required (U.S. Army Corps of Engineers, EIS, 1988).

Manitoba

1. Distributions of rare and endangered species along the 10 km reach in Manitoba subject to infrequent flooding of longer duration are poorly documented. It is therefore speculative to suggest that some mitigation might be necessary for the loss of raptor nesting sites along the flooded zone. Field surveys would be required to substantiate such losses and the loss of foraging habitat.

12.8.1.3 Residual Impacts

Saskatchewan

1. The availability of foraging habitat and associate prey (ground squirrels) for the local ferruginous hawk population would be reduced significantly. Foraging opportunities may be irretrievably lost if local ground squirrel populations (the preferred prey) are negatively affected.

North Dakota

1. None.

Manitoba

None.

12.8.1.4 Information Deficiencies

International

1. Information and data are lacking for comparative evaluations of habitat quality in the flooded area in terms of nesting and foraging value and the surrounding range for the ferruginous hawk and Baird's sparrow in Saskatchewan and Manitoba. The Proponent should evaluate these areas if the project proceeds.

2. Quantitative baseline information is also lacking on the status of Baird's sparrow in the Souris Valley, particularly in the vicinity of the Rafferty and Alameda Dam sites. The Proponent should evaluate this information gap if the project is to proceed.

3. Precise and recent surveys data are lacking on nesting sites for burrowing owls and ferruginous hawks in the Souris Valley.

4. Current information on the status of rare and endangered species along the Manitoba portion of the Souris Valley, in particular the 10 km reach affected by flooding downstream of the international boundary, is lacking. The Proponent should evaluate this information gap if the project is to proceed.

12.8.2 Rare Flora

The Souris River valley is exceptionally rich in plant species that can be classified as rare. In this valley within Saskatchewan and Manitoba, 69 species are rare. Nineteen of these species are rare in Canada, and, therefore, are of both provincial and national significance.

12.8.2.1 Project Impacts

Saskatchewan

1. Witch grass occurs within the area that would be inundated by the Rafferty Reservoir, side-oats grama grass would be inundated by the Alameda Reservoir.

2. Buffalo grass, whorled milkweed, tumble grass, white milkwort, white-flowered prairie parsley and heavy-fruited sedge occur in valley bottom and lower slope habitats. These provincially and nationally significant plants could be adversely affected by the altered hydrologic regime and some could be extirpated from within Canada. The Proponent should assess the distribution and abundance of these rare plants and monitor population trends over the long term.

North Dakota

1. The Project is not expected to have a major impact on plant species considered rare in North Dakota.

Manitoba

1. Heavy-fruited sedge, buffalo grass, whorled milkweed, and tumble grass are species of national significance that probably inhabit the floodplain of the Souris River in Manitoba. Populations of these species could be adversely affected by the altered hydrologic regime resulting from the Project. The Proponent should assess the distribution and abundance of these rare plants on the floodplain and monitor their population trends over the long term.

12.8.2.2 Mitigation of Project Impacts

Mitigation for plants lost due to reservoir filling or reduction of downstream flooding is not possible. Impacts of channelization below Rafferty Dam could be reduced through construction practices and maintaining cut-off meander-loop habitat. Irrigation development impacts on rare plants could be reduced by restricting development in areas with significant rare plant populations. Neither Canada nor Saskatchewan has legislation for the protection of rare and endangered species. Therefore, the federal government has no authority under which it could stop or modify the Project to protect these rare plant species.

12.8.2.3 Residual Impacts

1. Witch grass occurs within the area that would be inundated by the Rafferty Reservoir, side-oats grama grass would be inundated by the Alameda Reservoir.

2. Buffalo grass, whorled milkweed, tumble grass, white milkwort, white-flowered prairie parsley and heavy-fruited sedge occur in valley bottom and lower slope habitats. These provincially and nationally significant plants could be adversely affected by the altered hydrologic regime and some could be extirpated from within Canada. The Proponent should assess the distribution and abundance of these rare plants and monitor population trends over the long term.

3. Heavy-fruited sedge, buffalo grass, whorled milkweed, and tumble grass are species of national significance that probably inhabit the floodplain of the Souris River in Manitoba. Populations of these species could be adversely affected by the altered hydrologic regime resulting from the Project. The Proponent should assess the distribution and abundance of these rare plants on the floodplain and monitor their population trends over the long term.

12.8.2.4 Information Deficiencies

The distribution and abundance of rare plant species in the Souris River floodplain in Saskatchewan and Manitoba needs to be studied in more detail. Particular emphasis should be placed on the reaches to be inundated by the Rafferty Reservoir. This must be undertaken by the Proponent prior to the project proceeding.

12.9 Navigable Waters Protection

12.9.1 Project Impact

Saskatchewan

Both the Rafferty Dam on the Souris River and Alameda Dam on Moose Mountain Creek would interfere substantially with navigation as defined by the Navigable Waters Protection Act (NWPA).

12.9.2 Mitigation of Project Impacts

Saskatchewan

The Project Proponent could mitigate the impacts on navigation and related concerns for public safety through design considerations of the proposed works, and through the proper marking of any hazards to navigation.

12.9.3 Residual Impacts

None.

12.9.4 Information Deficiencies

The province of Saskatchewan has received instructions from Transport Canada with respect to the information required to assess the Project under the Navigable Waters Protection Act (NWPA). As a Crown Agency, the province does not require a licence under the NWPA, and the province has not applied for a licence under the Act. As a result, the design and operating information needed to assess the impacts on navigation are not available.

12.10 Conclusions

The review of project impacts on areas of federal responsibility has identified those impacts which are deemed to be significant, whether or not they are mitigable, and areas where additional information is required to fully assess the impacts of the Project. The following recommendations are proposed:

(i) Where significant impacts are identified in areas of federal responsibility, the responsible agencies should develop and implement mitigation plans;

(ii) Prior to a federal decision on the Project, information deficiencies must be addressed by the responsible agencies. This information would also ensure an adequate data and information base for post-Project operation and monitoring; and

(iii) To ensure that all concerns are considered, Environment Canada could provide continuing opportunity for public input on federal areas of responsibility with respect to the Project.

13 RESPONSE TO ISSUES RAISED THROUGH THE PUBLIC REVIEW PROCESS

13.1 Introduction

A total of 281 briefs, either oral or written, were received from the public. These briefs raised numerous questions and concerns. Some of these questions were directly related to the content of the IEE, but the majority were related to areas beyond the scope of the IEE.

Questions and comments directly related to the IEE have been addressed within the text of the final IEE. This section is intended to provide a response to the questions and concerns which were frequently raised. Many of the questions raised do not involve federal responsibilities, but are of provincial or United States concern. In all cases, responses to questions attempt to specify federal responsibilities, and the role of the IEE in addressing these responsibilities, which are linked to the environmental aspects of the Project.

It would not be possible to respond to all questions and concerns raised in the briefs and presentations. Questions have been combined or synthesized into a limited number of general questions which are intended to capture the basic issues.

13.2 Issues Raised and Responses

13.2.1 The Role of an IEE as Opposed to an Environmental Impact Statement

A number of briefs called for Environment Canada to conduct a comprehensive environmental impact assessment and panel review, under the federal Environmental Assessment and Review Process (EARP). However, the Initial Environmental Evaluation (IEE) was chosen by Environment Canada as the most appropriate first step at which to enter the EARP for assessing the federal ramifications of the Rafferty-Alameda Project.

The IEE provides the initiating department, in this case Environment Canada, with a sufficiently detailed examination of existing information, including mitigative measures. This information can be used to assess the potential impacts of the Project on the environment, and the necessity for further study. This was deemed to be the most cost effective approach, both in terms of time and other resources since it:

(a) is consistent with EARP;

(b) allows for decision-making without expending resources on detailed studies which may not be required;

(c) provides recommendations within a reasonable time frame; and

(d) does not preclude the option of further study such as completion of an Environmental Impact Statement (EIS) and/or conducting a full Panel review.

When an IEE or other initial assessment procedure identifies critical gaps in knowledge, or when the potential exists for significant environmental impacts for which mitigation is unknown, one of the courses of action is to develop an EIS. The EIS provides a more formalized documentation of a project's potential environmental impacts and the procedures for mitigation. It requires the issuance of guidelines or terms of reference, more detailed examination of the issues, and may require a considerable amount of time and resources to complete the appropriate studies.

The EIS, or other means of further study, are generally utilized when initial assessments are unable to provide clear direction for decision-making regarding the environmental impacts of the project. This initial assessment (IEE) completed for the Project is intended to provide guidance for decision-making by the Minister of the Environment within EARP. An assessment of the adequacy of the existing data and information base to assess the environmental implications of a project, and the need for further study, are key components of an IEE.

13.2.2 Scoping Procedure for the Initial Environmental Evaluation

During the public review of the IEE charges were made that the scoping process undertaken by Environment Canada did not follow the scoping procedures established for the EARP. Lack of consultation with the public resulted in a relatively narrow focus for the IEE, and restricted its evaluation to areas of direct federal responsibility. Specific areas that the IEE should have evaluated include the socio-economics of the Project, and Project alternatives.

Scoping of the IEE did not include a specific call for public input for two reasons. First, the instructions to the Department from the Minister required the completion of the IEE as quickly as possible, which restricted the possibility of calling for direct public input to the scoping. More important, however, was the unusual position of Environment Canada with regard to this Project. Environment Canada is the initiating department in terms of regulatory functions under the IRIA, and therefore responsible for preparing the IEE, but is not the Proponent or a sponsor of the Project.

As such, the department is not well placed to consider and evaluate alternatives or the economic feasibility of the Project, which is the responsibility of the Proponent (the SBDA in Saskatchewan and the U.S. Army Corps of Engineers in North Dakota). Environment Canada focused its attention in the IEE on the environmental implications of the Project as configured on areas of federal jurisdiction and interest. The federal government has technical knowledge to address the areas of federal responsibility.

The scoping process used for the IEE did include indirect input from the public and other government agencies through a review of public correspondence with the Minister of the Environment, review of the provincial public review process, review of the public involvement program of the Canada-Saskatchewan-Manitoba Souris River Basin Study, and discussion with other government agencies.

13.2.3 Independent Review

Some briefs and presentations have requested than an independent examination or review of the Rafferty-Alameda Project be conducted.

In ordering the Minister of the Environment to comply with the EARP Guidelines Order, the Federal Court expected Environment Canada to act as the initiating department. As required by the Process, the initiating department must screen or assess a proposal for which it has a decision-making authority, in this case, licensing of the Project under the IRIA.

Environment Canada's decision to conduct an IEE with a federal task force, led by departmental staff, was based on the availability of existing information and the fact that federal scientists familiar with environmental issues were best able to deal with the cross-disciplinary federal interests. If the IEE concludes that insufficient information is available to determine the significance of the environmental impacts on federal areas of responsibility, then the EARP Guidelines Order provides the option to order further study. Depending on need, additional studies could be undertaken within or outside the Department.

The role of the IEE is to provide guidance to the Minister in making a decision on not only the adequacy of technical data to address environmental implications and public concerns of federal interest about the Project, but also the best format by which such studies and public reviews should be undertaken.

13.2.4 Alameda Environmental Impact Assessment

Concern has been expressed about the change in location of Alameda Reservoir and the lack of detailed provincial assessment of the dam in its new location a few kilometres downstream. In developing the IEE, Environment Canada felt that the new location of the dam would not significantly change any characteristics that would affect areas of federal interest. For example, the amount of water stored was essentially unchanged and the probability that the reservoir would be thermally stratified remained. The assessment of federal areas of concern, therefore, was not constrained by the change in location.

13.2.5 Basin Wide Assessment

The scope of the SBDA EIS was, by definition, restricted to Saskatchewan, the area within the jurisdiction of the province. The U.S. Army Corps of

Engineers' EIS considered project features in North Dakota. The province of Manitoba subsequently produced, in 1988, a report on implications of the Project for that province.

The need for a basin-wide assessment of the implications of the Project was outlined in several briefs and presentations. Briefs presented in Manitoba in particular pointed out that a basin-wide EARP Panel review is required to examine the implications for Manitoba. The reply by the province of Manitoba to the Draft IEE emphasizes that the potential for adverse environmental impacts (particularly in Manitoba) and their mitigability are unknown. Manitoba's major concerns relate to uncertainties of the effects of the proposed project on the volume and timing of water flows into Manitoba and its quality.

Manitoba advocates the cooperative management of the water of the Souris River basin as a means to address Project impacts and mitigation. Such management must involve, Manitoba argues, the participation of all jurisdictions.

Cooperative, integrated management would provide an effective framework to address federal concerns associated with the Project, such as international waters, waterfowl and fisheries. This would provide the basis to consider the interests of all jurisdictions, including the interests of Saskatchewan and North Dakota to pursue flood control and water supply objectives.

13.2.6 Water Scarcity in the Souris River Basin

One of the major problems faced by the inhabitants of the Souris River basin is the variation in water availability over time. This problem was introduced frequently during the public meetings and is outlined in numerous briefs. Water in the Souris River is a feast or famine situation from year to year, and even from month to month. Periods of low flow are punctuated by devastating floods. Years of drought are eventually relieved by a series of wetter years.

The erratic nature of water availability in the Souris River basin led to the consideration of various forms of water storage schemes. The basic concept is to store water during periods of over-abundance for use during low flow periods. Rafferty Reservoir was envisaged as the means by which a more reliable basin water supply could be realized. Alameda Reservoir was designed to complement the operation of Rafferty Reservoir by storing sufficient water to make up Saskatchewan's 50 percent of natural flow commitment to North Dakota under the 1959 Interim Measures.

The Project would alleviate water scarcity problems, but as with any major water storage project, there are associated environmental issues that must be dealt with as a consequence of radically changing the hydrologic regime of the basin. These have been evaluated in the Project EISs, and in this IEE from a federal perspective. It should also be pointed out as well that the Project would not change the basic erratic nature of water availability in the basin, but attempts to partially modify the distribution of water between wet and dry periods. Management plans are still essential in dealing with extremes that would still occur that are beyond the design capability of the Project (or any other project) to handle.

13.2.7 Drought Proofing

The Project is intended to provide water storage for cooling the Shand Thermal Generating Station, irrigation development, recreation, and flood control. Numerous participants at the public meetings took this to mean the Project would provide drought proofing benefits for the region. One method of drought proofing is to store water for use during drier periods. The Rafferty and Alameda Project would store excess spring runoff for use later in the year, or in later years. Some drought proofing benefits, especially as a source of water for filling dugouts and for rural domestic users, would occur. During more severe droughts, irrigation requirements from the Alameda and Rafferty reservoirs would not be met, causing economic losses.

The Rafferty Reservoir would also provide wildlife water needs during droughts, such as waterfowl staging. However, over-population on limited water bodies often results in conditions for disease. Conditions downstream of the reservoirs during drought years should not be different from the present during drought periods. Little or no flow would be expected in the Souris River in Saskatchewan.

While the reservoirs would provide a reliable supply of water for the intended uses during most years, it must be recognized that during prolonged or severe droughts, the Project may not be able to meet all the increased demands for water. As a result, the actual economic impact of severe droughts could be increased as a result of the Project.

13.2.8 Flood Control

The Project flood control benefits constitute almost 50 percent of the project costs: $60 million for flood control in the United States and $2.5 million for flood control in Canada. The logic of constructing a flood control project for Minot and other areas of North Dakota on Canadian territory in exchange for $60 million in financial compensation has been questioned. Some briefs have indicated that flood control options such as the Burlington Dam and the Lake Darling raise were strongly opposed in the 1970s by farm interests in the reservoir areas in North Dakota. The loss of land in Canada is considered as a perpetual, irreversible disbenefit, and is not commensurate with financial compensation.

The issue of flood protection in Saskatchewan and North Dakota, and financial arrangements made to compensate Saskatchewan for Project costs, including land, is a matter for the province and the state to decide. Federal interests and concerns are specific to areas such as interjurisdictional waters, fisheries and migratory birds. It is also in the federal interest to ensure that the interests of Manitoba are considered in the Project planning. The IEE has focused on these concerns, and recommendations arising from the IEE, in particular, the need to undertake an integrated assessment of all the water users needs of all jurisdictions. The planning and assessment process arising from interjurisdictional consultations may have implications to the operation of the Project for flood control purposes.

13.2.9 Ground Water Pumping - Rafferty Reservoir

Concern was expressed that ground water would be pumped into Rafferty Reservoir for subsequent use as cooling water for the Shand Thermal Generating Station. Such pumping would be carried out in years when there was insufficient water in storage from surface water runoff to meet cooling water demands for Shand. The relatively poor-quality ground water could cause downstream water quality problems should it be released from Rafferty Reservoir.

There are no plans that call for pumping ground water into Rafferty Reservoir. The Saskatchewan Power Corporation does, however, have a contingency plan that calls for pumping ground water directly to Shand where, after treatment, it would make up about half the cooling water supply. The remaining supply would consist of Estevan sewage effluent and coal mine dewatering water. The Shand cooling system is a closed system with no outlet to the Souris River.

Ground water cooling is described in the 1987 Shand EIS. Public concern about possible ground water pumping to replenish Rafferty or Alameda reservoirs could be addressed by a specific prohibition in any future IRIA licence.

13.2.10 Project Alternatives

A number of briefs and presentations pointed out that the Project has been presented in the SBDA's EIS as the only solution to many regional water scarcity and economic development problems, and alternatives for each of the Project purposes have not been evaluated.

The Proponent states that the Project would provide substantial benefits by providing cooling water to the Shand. Opponents argue that the better alternative is to buy hydroelectric power from Manitoba or North Dakota rather than to generate thermal power through Shand Power Project. Saskatchewan Power Corporation officials have stated, however, that the Shand Project is the least cost alternative for the future power needs of the province.

Environment Canada or the federal government is not a proponent or sponsor of the Project, and thus cannot evaluate or comment on the economic desirability of one project alternative over another; this is a provincial decision. Federal action is focused, as is the IEE, on issues of federal jurisdiction and concern that are affected by the Project.

13.2.11 Economic Feasibility

The Proponent and several supporting briefs during the public hearings have argued that this multi-purpose Project is economically viable, and desirable from a regional development perspective. Opponents question this claim, arguing that most of the benefits are over estimated and costs under estimated, and methodologies do not meet federal standards.

The SBDA's EIS states that the Project is economically justified as it has a benefit-cost ratio greater than one, at a five percent discount rate. The benefit-cost ratio is also shown greater than one at the ten percent discount rate, only in cases where the sensitivity analyses included either the indirect benefits or forward linkage benefits. To satisfy the test of economic viability, the federal benefit-cost guidelines stipulate that the Project must have a benefit-cost ratio greater than one at a ten percent discount rate, including direct benefits only. The Project does not meet this test; although the economic analysis methodology has not been evaluated in detail to determine if it meets Treasury Board requirements.

The position of Environment Canada has been that the issue of economic feasibility, as contained in the SBDA EIS, is outside federal jurisdiction. The federal government has no direct financial or resource commitments in the Project. Therefore, the Treasury Board guidelines for Benefit-Cost Analysis do not apply.

13.2.12 Sustainable Development

The issue whether the Project constitutes sustainable development was raised at the public meetings and in a number of briefs. It was raised in terms of questioning whether the existing water resource base can sustain the creation of the reservoirs and the associated users over the long term. The particular concern is the ability of the Project to sustain the multipurpose uses which have been identified by the Project Proponent, for both the present and for future generations.

The most significant question relates to the filling probabilities of Rafferty and Alameda reservoirs. Simulations for the periods 1912 to 1974 and 1948 to 1974 indicate a filling time of 43 years and seven years, respectively, for both reservoirs. When combined with expected evaporation losses and the projected climate change characterized by warming of the Great Plains of North America, the reservoirs may not be able to supply all consumptive and non-consumptive uses in the future. Recreation, for example, depends on a specific range of reservoir levels.

Any water storage project involves physical and environmental effects that are both positive and negative, because it radically changes the hydrologic regime of a basin. This IEE has concluded that a basin-wide management plan is desirable to integrate the water use needs of all jurisdictions.

Such a plan would explicitly recognize the variability and capability of the water resources to sustain identified water uses over the long term.

13.2.13 Regional and Economic Development, and Water Management Benefits of the Project

A number of briefs and presentations indicated that there are significant benefits to Saskatchewan from the Project that the draft IEE did not address or present. The Project would allow the improvement of water quality, through, for example, the removal of Estevan treated sewage discharges from the Souris River for use at Shand would improve water supplies for agriculture, industry, and municipalities, and would create long term job opportunities, especially in secondary industry and tourism.

The purpose of the IEE is to address information requirements within areas of federal responsibility. The federal government is not a proponent of the Project and, therefore, it is not appropriate to comment on regional development and water management aspects which are the responsibility of the province (and the U.S. Army Corps of Engineers in North Dakota). The IEE is focussed upon and comments only on those environmental aspects of federal interest and responsibility.

13.2.14 Public Information

A number of briefs raised concerns that the public has not been fully and accurately informed about all aspects of the Rafferty-Alameda Project.

The Project has been vigorously and continuously promoted by the Saskatchewan government and the SBDA. A provincial Board of Inquiry, the SBDA, project opponents and Environment Canada have all sponsored public meetings, and as a result, the public is as informed as can be reasonably expected on the technical aspects of the Project and specific areas of environmental concern.

However, there has been concern raised in the public meetings held by Environment Canada that the public information programs may have raised expectations of those who support the Project to an unrealistic level. The Project is perceived as being the key element in regional growth, diversification and as being the solution to water supply problems and providing high quality recreation with water-front property created by the reservoirs.

The Project would assist in regional economic development and be part of the resolution of water supply issues. There is merit in the observations that there is a danger in excessively rising expectations about what the Project can deliver. This is especially pertinent to recreation benefits. The fact that the reservoirs will not be at full supply level for extended periods, combined with fluctuating water levels and an unstable shoreline will limit recreation potential and the amount of lake-front suitable for cottage development. Water resource development is only one part, albeit an important part, in promoting regional development. The strength of world markets for the region's products are just as important. Secondly, even with the Project, the water resource of the basin would still be uncertain and variable. The Project would provide an increase in security in terms of shifting the availability of water from periods of abundance to those of scarcity. However, careful water resource planning is still required, recognizing the limits of the water resource, to ensure that uses can be sustained over the long term.

13.2.15 Water Export, Interbasin Diversion, and Free Trade

The issue that the Rafferty-Alameda Project is part of a water export plan, part of the Free Trade Agreement, was raised. Export is possible since the Project could potentially provide part of a link to a secure Rocky-Mountain-fed source of water. A future interbasin transfer proposal to the Souris from the Qu'Appelle River could link the South Saskatchewan River, through releases at the existing Qu'Appelle Dam at Lake Diefenbaker, to the Souris. The South Saskatchewan River system rises in the Rocky Mountains of Alberta. Once Canadian water is in the Souris, it could be pumped into the Missouri for delivery southward. Consequently, the Project should be stopped since water export is not in the national interest.

The federal government, and the governments of Alberta and Saskatchewan, are on record as opposing water export through interbasin diversion. The Federal Water Policy, approved by Cabinet in 1987, states the federal government will

> **"take all possible measures within the limits of its constitutional authority to prohibit the export of Canadian water by interbasin diversions; and strengthen federal legislation to the extent necessary to fully implement this policy".**

Federal Trade Ministers have also stated on numerous occasions that water is not part of the Free Trade Agreement.

Water diversion from the Qu'Appelle to the Souris basin was investigated as part of the Canada-Alberta-Saskatchewan-Manitoba Saskatchewan-Nelson Basin Study in the early 1970s. This concept did not involve export of water to the United States as waters were to be transferred from the lower Souris in Saskatchewan via the Antler River to rejoin the Souris in Manitoba, north of the international boundary. Diversion is not under consideration by the province, and the SBDA's studies indicate that there is sufficient runoff within the basin to accommodate Project uses. Should the question of diversion from the South Saskatchewan River to the Souris River be raised in the future, the federal government would evaluate the socio-economic and environmental consequences in the national interest, and would ensure that water export would not be part of the proposal.

13.2.16 The 1959 Interim Measures

There were a number of questions directed at the 1959 Interim Measures, particularly with respect to the role they play in protecting the downstream (flow) interests in North Dakota and Manitoba. This section first outlines the origin of the Measures and how they are administered, and follows by answering specific categories of public concerns that were raised with respect to the application of the Measures to the Project.

Two provisions of the 1959 Interim Measures for the apportionment of the Souris River are of direct relevance to the proposed development of the Rafferty and Alameda Project:

1. Saskatchewan's **"right to divert, store, and use waters which originate in the Saskatchewan portion of the Souris River basin, provided that such diversion, storage and use shall not diminish the annual flow of the river at the Sherwood Crossing by more than fifty percent of that which would have occurred in a state of nature."**

2. Manitoba's **"right, except during period of severe drought, to receive for its own use . . . . during the months of June, July, August, September, and October . . . . regulated so far as practicable at the rate of twenty (20) cubic feet per second"** [0.566 m^3/s].

Arrangements for the apportionment, or sharing, of the waters of the Souris River originated with a reference, by the governments of Canada and the United States to the IJC under Article 9 of the Boundary Waters Treaty in 1940. The Commission made recommendations to governments for apportionment according to a formula established at that time and subsequently revised in 1959. It should be noted that the Measures apply only to water quantity and do not include any water quality considerations. Compliance with the Interim Measures is monitored on behalf of governments by the IJC-appointed International Souris River Board of Control, a six-person Board with membership drawn equally from each country. Board members serve as individuals, not national representatives. The current members all live in the mid-continent and have direct professional interest in the Souris River basin. The Board reports annually to the IJC in compliance with the Measures.

The negotiated operating plan for the Project calls for a change in the 1959 Interim Measures as it affects the Saskatchewan-North Dakota apportionment. That is, under defined natural flow and Lake Darling water levels, Saskatchewan could retain 60 percent (rather than 50) of the natural flow. These conditions would occur in high flow years and form an "evaporation credit" to Saskatchewan. Such situations would occur infrequently.

There are two disparate views of the applicability of the 1959 Interim Measures to the Project. Saskatchewan and North Dakota regard the Measures as a legal right. They reason, therefore, that North Dakota and Manitoba have enjoyed a "windfall benefit" on account of Saskatchewan's inability to retain its share of Souris River waters. It follows, then, that the environmental impacts of the Project should not be evaluated against present conditions but against a 50 percent flow scenario. On the other hand, Manitoba views the Measures as an entitlement which must be tempered by the application of the Boundary Waters Treaty itself, particularly Article 4 pertaining to water quality. The environmental impacts of the Project, in that line of reasoning must be evaluated against present conditions.

Resolution of these two positions would require the application of complex and conflicting water law in Canada, in the United States, and internationally. Of necessity, this would have to include consideration of water legislation, as written and as practiced in both countries, riparian rights under English common law, the doctrine of prior appropriation, the concept of beneficial use, and the application of Helsinki Rules, among others.

During the public meetings, the effect of reservoir filling time on transboundary flows arose on a number of occasions. The 1959 Interim Measures, and the proposed modification, do not consider filling time of reservoirs. That is, if the reservoirs fill in five years or fifty years, there is no difference in the way in which they would be operated to meet water apportionment needs at the Saskatchewan-North Dakota boundary. The concept of filling time is, therefore, irrelevant to international water quantity considerations although it is important from other perspectives. It should also be noted that the reservoirs do not have to be full to meet Project water demands, such as apportionment obligations to North Dakota.

Another public concern related to application of the drought criteria to the 0.566 m^3/s flow from North Dakota to Manitoba. It should first be noted that the drought criteria are based on specified storage in North Dakota and can, therefore, be invoked only under clearly defined circumstances. For example, since 1959 the criteria have been invoked in dry years in 1961 and 1962 but not in 1977 or 1988. Application of the drought criteria does not imply zero releases to Manitoba. In 1961, monthly mean flows were reduced to 0.276 m^3/s in September 1961 and 0.136 m^3/s in June 1962. The extent of flow reductions is considered by the International Souris River Board of Control and appropriate allocations for domestic supply and livestock watering approved by the Board.

The simulation models of the Souris River were run to determine how often the drought criteria would have been invoked had the Project been in place since 1912. Depending on the assumptions used, the drought criteria could have been applied in five to seven years, under simulated historic and Project conditions, respectively. As indicated in the draft IEE, a greater concern is the overall effect of reduced flows, albeit greater than 0.566 m^3/s.

13.2.17 Requirement for a Souris Basin-wide Management Plan

A number of briefs and presentations noted the desirability of establishing a Souris basin-wide management plan prior to proceeding with the Project. The Canada-United States Agreement on the Project that was concluded at the officials level, between Saskatchewan, Manitoba, North Dakota, and the two federal governments was focused on flood control, primarily the operation of Project features in Saskatchewan and North Dakota. The Agreement, as such, did not address basin-wide management.

In the review of technical and public comments on the Draft IEE, it was concluded that a basin-wide management plan would provide an effective framework to address federal interests such as international waters, waterfowl, and fisheries, with respect to the Project. The Plan would provide an opportunity to systematically address the requirements of all water uses in the basin, provide operating guidelines for the Project, and to evaluate the effects of future developments in the basin. Included in the Plan could be the development of consistent data bases on water quantity, quality, and use, and water quality objectives for all jurisdictions, which have been identified in this IEE as desirable mechanisms to address federal interests.

Given the international nature of the planning process, this concept would need to be discussed with Saskatchewan, Manitoba, and United States authorities to determine the appropriate scope and possible roles that the two existing Boards under the IJC would play in the planning process. The International Souris River Board of Control could be involved with respect to implications for monitoring of the 1959 Interim Measures.

13.2.18 Operation of National Wildlife Refuges

The operation of the national wildlife refuges in North Dakota was raised in Manitoba as being an important factor in determining the amount of water that is delivered to Manitoba by North Dakota. The operation of Lake Darling and the refuges is an instrumental part in the severe drought criteria that reduces the flows at the Souris River at Westhope below 0.566 m^3/s (20 cfs).

This IEE agrees that operation of the refuges has a significant effect on flows reaching Manitoba, and refuge operation must be included in any management plan for the Project discussed by the governments of Canada and the United States for the Souris basin.

13.2.19 Evaluation of The Effects of the Rafferty-Alameda Project and U.S. Works on the Province of Manitoba

All potential impacts at the North Dakota-Manitoba boundary which fall within federal areas of responsibility have been considered. It is readily apparent that deficiencies exist in several areas including integrated basin water management, water quality, migratory birds, fisheries, and rare and endangered species. These have been reported in the IEE.

Manitoba's primary concerns relate to "the volume and timing of water flows into Manitoba and the effects on water quality resulting from the accumulated effects of the proposed Project together with the adjustments to water control and water use that will occur in North Dakota". Until Manitoba reconsiders its water needs and obtains approval for a modified allotment from North Dakota, the Interim Measures of 1959 are in effect through administration of the International Souris River Board of Control, under the IJC. The state of North Dakota has provided assurances to Manitoba that it would abide by these Interim Measures under Project and U.S. flood control conditions and that it would abide by the Boundary Waters Treaty.

Manitoba is concerned that there has been no thorough, scientifically credible analysis which predicts the impacts on all water quality parameters at the North Dakota-Manitoba boundary. Environment Canada consulted with scientists in the preparation of its IEE and has used this professional guidance in drawing its conclusions, especially where definitive descriptive projections were absent. Analysis conducted by the SBDA has now dealt scientifically with the impacts as they related to total dissolved solids, nitrogen and phosphorus, although the approach and the results have not yet been reviewed by all jurisdictions. If the analysis is found to be valid, many other parameters can be scientifically assessed by inference. Environment Canada is confident that the Project and U.S. works would not significantly alter the metal and pesticide content of the river above levels which would occur without these developments.

The major uncertainty is the biological integrity (diversity, community and species abundance) of the river and its response to upstream water developments. A negative change would impair the aesthetic value of the river and instream impoundments within Manitoba. Manitoba has commissioned (July 1989) a water quality study to assess flow and biology relationships.

International water quality objectives must be formulated and applied at both boundary crossings of the Souris River. These objectives would secure the commitment of upstream jurisdictions to maintaining adequate water quality in the river. At the same time, international objectives would provide the downstream jurisdiction with descriptive indicators of water quality which they can expect not to be exceeded. If exceedances are observed, the jurisdictions would then assess the magnitude of the concern and undertake appropriate water management responses. These objectives would assure Manitoba that the water quality of the Souris River would be protected for their long term water use benefits through a coordinated jurisdictional (basin) management approach.

In consideration of the quality of the Souris River at the North Dakota-Manitoba boundary, there is confidence in the predictions concerning dissolved solids (and therefore most of the individual ions and salts); synthetic organic substances (e.g. pesticides); metals (e.g. mercury and lead); and, trace elements (e.g. boron and selenium). Uncertainty still exists concerning the response of the biological system to changes in river flow, and concerning the behavior of nutrients relative to the operation of developments in the United States. Without the Project, water quality in the Souris River will continue to be poor during low flow periods of summer and winter. The extent to which the upstream works can afford opportunities for improving water quality during these periods remains speculative and a matter for consideration through bilateral channels, the IJC or parts of various licences and permits within jurisdictions involved.

13.2.20 North American Waterfowl Management Plan

There was concern expressed that the environmental impacts of the Project would compromise the intent of the **North American Waterfowl Management Plan (NAWMP)**. Substantial losses of waterfowl habitat are expected, and mitigation would be required by the Proponents.

The goals and objectives of the (**NAWMP**), as they relate to the Project, are briefly described in subsection 7.2. Further details are contained in the **NAWMP** document itself and, for Saskatchewan, in the **Saskatchewan Implementation Plan** document (also referred to in subsection 7.2).

Through the **NAWMP**, Canada and the United States have agreed to improve waterfowl habitat in prairie Canada and the United States through changes in land use practices. The goal is to protect and improve prairie wetlands, along with adjacent upland nesting cover, with a view to increasing prairie duck populations to levels experienced in the 1970s.

The **Saskatchewan Implementation Plan** describes the land management programs which are to be implemented over a 15-year period in order to meet the Saskatchewan duck population objectives. The Plan is based on the knowledge of current duck population levels and habitat conditions, which can be referred to collectively as the base conditions. Duck population objectives for Saskatchewan are to be met by producing additional ducks from improved, managed habitat in the southern part of that province. Any further destruction of habitat through, for example, Rafferty-Alameda Project development or agricultural practices such as drainage of wetlands or clearing of wetland margins, would serve to diminish the base habitat and duck population conditions. This, in turn, would undermine the efforts being made through the **NAWMP** and could result in failure to meet the population objectives agreed upon by Canada and the United States.

Preservation of existing duck habitat conditions in southern Saskatchewan and North Dakota is crucial in order to protect the integrity of the Canada-U.S. **NAWMP** and to ensure that the money and the effort expended will not be in vain. It is this requirement that resulted in the insistence that all losses of waterfowl habitat, which would be caused by the Project, be completely mitigated in order that no net loss of waterfowl production would occur as a result of the Project.

13.2.21 Waterfowl Impacts/Mitigation

A number of presentations and briefs expressed concern about how the waterfowl production losses, associated with the Project, were calculated.

Subsection 7.5 describes in detail the data and methodology used to determine the duck production losses which are expected to occur in Saskatchewan and North Dakota should the Rafferty-Alameda Project, and associated Souris River Basin Project in North Dakota, be constructed and operated as proposed.

The loss figures produced indicate the numbers of ducks which would have to be produced from lands selected by the proponents, the SBDA and the U.S. Army Corps of Engineers, for the purpose of mitigating the expected duck production losses. These numbers would be over and above whatever the present duck production from those lands is. Because mitigation of waterfowl impacts is the responsibility of the proponents, no description of possible mitigation alternatives was included in the draft IEE. Rather, the loss figures should be used by the proponents in the development and implementation of mitigation and monitoring plans to ensure that no net loss of waterfowl production occurs in Canada or the United States as a result of the Rafferty-Alameda and Souris River Basin projects.

13.2.22 Wetland Drainage

Concerns were raised that wetland drainage, and resulting loss of waterfowl habitat, would be encouraged with the Rafferty-Alameda Project in place.

In subsection 7.5.2.3, reference is made to assurances given by the province of Saskatchewan that there would be no drainage of off-river wetlands for the purpose of increasing the supply of water to either the Rafferty or Alameda Reservoir. The remainder of this subsection addresses the potential impacts on waterfowl of wetland drainage, carried out by landowners, which might be stimulated or encouraged by the existence of the two reservoirs.

A moratorium on wetland drainage in the Souris Basin has been in effect in order to alleviate the extent of flooding along downstream reaches of the Souris River. With the reservoirs in place, these downstream reaches would be protected from the effects of increased inflows from off-river drainage projects and, therefore, the province of Saskatchewan could possibly deem it appropriate to remove the wetland drainage moratorium.

Because of the implications of further wetland drainage in the Souris Basin to waterfowl populations and the success of the **NAWMP**, Environment Canada recommended in subsection 7.5.2.3 that the province of Saskatchewan take immediate steps to ensure that no further drainage occurs without full in-kind/ acre-for-acre mitigation of habitat lost.

13.2.23 Scope of Migratory Birds Assessment

The decision to restrict the evaluation of the Project impacts on migratory birds to waterfowl was questioned in a number of presentations. These individuals felt the evaluation should examine all species of migratory birds regulated under the Migratory Birds Convention Act.

As indicated in subsections 7.1 and 7.5.1, the scope of the assessment of the potential impacts of the Project on migratory birds was guided by the nature of the concerns expressed during the Rafferty-Alameda Board of Inquiry public hearings and the importance placed on waterfowl by the Canada-U.S. **North American Waterfowl Management Plan**. In addition, the present situation of extremely depressed waterfowl population levels in the Prairies pointed to the need to focus evaluation efforts on identifying to what extent the Project would impact on waterfowl and, consequently, to what extent mitigation would be necessary to ensure that no further decline in waterfowl populations occurred as a result of the Project.

It is acknowledged that waterfowl would not be the only migratory bird species adversely affected by the Project. However, it should be understood that, at the IEE level, assessments of potential impacts of a project are generally based on available data and information. Fairly good, up to date information on waterfowl use and habitat was available throughout most of the study area. That was not the case for other migratory birds. An assessment of the effects of the Project on non-waterfowl migratory bird species would have required data collection activities which would have taken more time to carry out than was available for preparation of the IEE.

13.2.24 Navigable Waters

The navigability of the waters of the Souris, and the necessity for the SBDA to meet the requirements of the Navigable Waters Protection Act (NWPA), administered by Transport Canada, elicited a number of comments and concerns from the public. The Souris River and Moose Mountain Creek were considered to have exceptionally minor interest in terms of navigation, and during low and zero flow periods, navigation would be non-existent.

The definition of navigability and scope of the NWPA to regulate navigation is outlined in Section 11. The Application Guide for the NWPA defines "navigable waters" as any body of water capable of being navigated by floating vessels of any kind, which would include recreational vessels. Any works that affect navigation, such as dams, are relevant to the NWPA.

Consequently, the Souris River and Moose Mountain Creek, the Rafferty and Alameda reservoirs, and the Project dams would be subject to the NWPA. Although Crown agencies are exempt from the NWPA, Environment Canada has urged the SBDA to file an application. This would ensure that technical advice from Transport Canada could be incorporated into the Project design and operation to ensure public safety and access with respect to navigation.

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- Chapter 2 Social & Economic Circumstances
- Chapter 4 Public Involvement
- Chapter 5 Geology & Mineral Resources
- Chapter 6 Hydrogeology
- Chapter 7 Hydrology
- Chapter 8 Water Quality
- Chapter 9 Soils
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Annex 1

Metric Conversion Table

cubic metre per second (m^3/s) = 35.3 cubic feet per second

cubic decametre (dam^3) = 0.811 acre feet

hectare (ha) = 2.47 acres

kilometre (km) = 0.621 miles

metre (m) = 3.28 feet

microgram per litre (ug/L) = part per billion

milligram per litre (mg/L) = part per million

square kilometre (km^2) = 0.386 square miles

Annex 2

List of Acronyms Used

AUM - Acres/Animal Unit/Month
CCREM - Canadian Council of Resource and Environment Ministers
CFS - Canadian Forestry Service
CLI - Canada Land Inventory
COSEWIC - Committee on the Status of Endangered Wildlife in Canada
CWF - Canadian Wildife Federation
DFO - Department of Fisheries and Oceans
DO - Dissolved Oxygen
EARP - Environmental Assessment and Review Process
EIS - Environmental Impact Statement
EMA - Environmental Management Associates
FEARO - Federal Environmental Assessment and Review Office
FSL - Full Supply Level
HEP - Habitat Evaluation Procedure
IEE - Initial Environmental Evaluation
IJC - International Joint Commission
IRIA - International River Improvements Act
MFL - Maximum Flood Level
NAWMP - North American Waterfowl Management Plan
NDSDH - North Dakota State Department of Health
NWA - National Wildlife Area
NWPA - Navigable Waters Protection Act
NWR - National Wildlife Refuge

PFRA - Prairie Farm Rehabilitation Administration

RSCC - Regional Screening and Coordinating Committee

SAR - Sodium Adsorption Ratio

SBDA - Souris Basin Development Authority

SIP - Saskatchewan Implementation Plan

SPC - Saskatchewan Power Corporation

TDS - Total Dissolved Solids

USEPA - United States Environmental Protection Agency

USFWS - United States Fish and Wildlife Service

USGS - United States Geological Survey